M. M. GIBBONS

Volume 45. September, 1931. $4.00 a Year.
Number 3. Pages 199-314. $1.25 a Number.

JOURNAL

OF THE

New England Water Works Association.

ISSUED QUARTERLY.

PUBLISHED BY
THE NEW ENGLAND WATER WORKS ASSOCIATION,
714 Tremont Temple, Boston, Mass.

Entered as second-class matter September 23, 1903, at the Post Office at Boston, Mass., under Act of Congress of March 3, 1879.

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New England Water Works Association
ORGANIZED 1882.

Vol. XLV. September, 1931. No. 3.

This Association, as a body, is not responsible for the statements or opinions of any of its members.

THE LAW OF INTERSTATE WATERS AND ITS APPLICATION TO THE CASE OF THE DELAWARE RIVER.

BY THADDEUS MERRIMAN.*

[*Read October 1, 1931.*]

In venturing outside the narrow confines of his science into the broad field of Interstate Common Law, the author finds justification in the words[1]† of Sir John Powell:

> Let us consider the reasons of the case. For nothing is law that is not reason.

Reason is not to be monopolized, and logic is the common property of all men. Interstate water law, as it stands today, may be said to be the joint product of the lawyer and the engineer. The engineer prepares the facts; the lawyer presents them, and, as they are truthfully convincing, so is the decision rendered and the law declared. Thus does the engineer play a fundamental part in the formulation of the principles of interstate water law, and therefore does the author feel free to discuss them, even though he is without license to practice law of any kind.

The subject of waters is as old as Man himself. From basic principle, from fundamental justice and from common usage there has sprung a great body of common law which governs and controls the courts in their decisions. Each decided case serves as a precedent for the future. The first decision on any principle is equally as convincing as the last, while multiplicity of decisions is conducive of certainty.[2] Thus does the aspect of the Common Law exhibit changes as the generations pass. These changes are not a mere function of the passage of time but result from the necessity which compels the law to keep abreast of the requirements of the age in which it is declared.

The Common Law is the visible expression and practical application of abstract principle and is absolute as to both time and place. While the Statute Law may be modified by amendment or added to by new enactment, the Common Law adjusts itself to surrounding economic and social conditions just as fast as cases arise. In this process of evolution there is naturally a lag. That is to say, civilization advances somewhat more rapidly

* Chief Engineer, Board of Water Supply, New York, N. Y.

† All numbered references are listed at the end of this paper.

than the principles of the Common Law can be declared. This, of course, is a most fortunate circumstance in that the courts are never called upon to lay down a principle in advance of the time when it becomes inevitable. Thus is the Common Law seen as a vital and growing thing, and so does it differ from a system of law like that of the Medes and the Persians "which altereth not." The Common Law is an elastic and adaptable code, always seeking to keep reasonable pace with the needs of humanity and, in this ever changing world, to measure out Justice as Truth and Equity require.

The Riparian Doctrine.

The riparian doctrine dates back to the days of Charles the First, when it became established as one of the tenets of the Common Law of England and, with the great body of that law, was later transplanted to American soil. This doctrine is a principle of abstract right and, when first declared, furnished a reasonable means for settling the situations it was designed to compose. This almost sacrosanct principle was the outcome of pure reasoning and took no account of the practical side of the many diverse factors involved in its application. The words[3] of Mr. Justice Holmes most eloquently point out the limitations which beset every abstract principle of law. He wrote:

> All rights tend to declare themselves absolute to their logical extreme. Yet all in fact are limited by the neighborhood of principles of policy which are other than those on which the particular right is founded, and which become strong enough to hold their own when a certain point is reached.

The riparian doctrine was stated[4] by Chancellor Kent as follows:

> Every proprietor of lands on the banks of a river has naturally an equal right to the use of the water which flows in the stream adjacent to his lands, as it was wont to run (*currere solebat*), without diminution or alteration. No proprietor has a right to use the water to the prejudice of other proprietors, above or below him, unless he has a prior right to divert it, or a title to some exclusive enjoyment. He has no property in the water itself, but a simple usufruct while it passes along. *Aqua currit et debet currere ut currere solebat* is the language of the law. Though he may use the water while it runs over his land, as an incident to the land, he cannot unreasonably detain it, or give it another direction, and he must return it to its original channel when it leaves his estate.
>
> Without the consent of the adjoining proprietors, he cannot divert or diminish the quantity of water which would otherwise descend to the proprietors below. . . . This is the clear and settled general doctrine on the subject, and all the difficulty that arises consists in the application. The owner must so use and apply the water as to work no material injury or annoyance to his neighbor below him, who has an equal right to the subsequent use of the same water. . . . All that the law requires of the party by or over whose land a stream passes is that he should use the water in a reasonable manner, and so as not to destroy or render useless or materially diminish or affect the application of the water by the proprietors above or below on the stream.

The riparian principle is an expression of community interest in the waters of a stream as in a jointly owned property of which all the riparian

proprietors are equal stockholders. No one of these owners has a greater right than any other, and no one may claim preference over another. The rights of a riparian owner are rights of property, and he may not be deprived thereof except by due process of law and the payment of just compensation. The title of a riparian owner to the waters which flow over his land is, however, no better or stronger than his title to the land itself and, as will be shown later, his title to the water, in case his land happens to be located on an interstate river, is always subordinate to the superior rights of the sovereignties located on the stream above him. The title of such an owner is not of the same kind and quality as that of a proprietor on a stream which rises and has its entire being within the sovereignty of a single state.

The essence of the riparian doctrine declares that the waters of a stream must be allowed to flow as they were wont. In other words, they should not, to any extent or degree whatever, be diminished in quantity or impaired in quality by any riparian owner. In this practical world, so absolute and inflexible a rule is naturally impossible of strict application. Reasonable use is, therefore, universally permissible, and the measure of reasonableness is, in general, whether the use substantially deprives a lower owner of his enjoyment of the water. The acid test of reasonableness, however, in most cases, seems to be whether or not the lower owner has suffered damage or is threatened with immediate financial injury.

Did not the principle of reasonable use operate to soften and modify the inflexible doctrine of *ut currere solebat*, many indispensable uses of the waters of flowing streams would be proscribed. For instance, no mill dam could be operated by any proprietor unless he secured the consent of all lower owners, while the development of hydro-electric power, involving the construction of great reservoirs, would be beset with insuperable difficulties. Each such development largely affects the natural flow of the stream on which it is situated. Usually the effect of such a plant is toward a regulation and averaging of the flow but, wherever the operation is as a "peak power" producer, great and sudden oscillations of flow are caused in the stream. Another manifestation of the shortcomings of this doctrine is to be found in the cumulative effect of many small mill dams all on one stream. When each of them is storing water the lower owners may be almost wholly deprived of water, and yet no single mill operator can be said to be unreasonable in his use of the stream.

Still more flagrant and notorious is the common practice of individuals, manufacturing establishments and municipal corporations in discharging their wastes and sewage into the streams which flow by their door steps. Every such act violates the rights of all lower owners, yet they seldom voice an objection, even though their security under the riparian doctrine is reinforced by the public health laws. Not until the pollution of a stream reaches the point of becoming a public nuisance is action looking towards its abatement usually taken. The riparian doctrine with respect to the count of the maintenance of the quality of flowing water is, to every intent

and purpose, a dead letter. In fact, an action seeking to prevent even the grossest pollution of a stream could hardly be brought with hope of success, except under the police power of the state as expressed in its legislation directed to the protection of the public health.

On the navigable waters of the United States the regulation of navigation is vested in the Congress, and the title of the land under such waters, which was formerly in the King, is now in the State in which the land is located. In such cases the Civil Law, derived from the principles of the august Roman Law, applies, and the rights of private owners of land, adjoining navigable waters, are special and limited, and they are not derived from, nor are they in any way dependent on, the riparian doctrine of the Common Law. In New York, title to the water and the land under water along streams which have been declared public rivers is in the State, and the adjoining riparian owner has no title either in the bed of the stream or in its waters. In Pennsylvania, the legal situation is practically identical, and all of the large fresh-water streams, including the Delaware River, are governed and controlled by the Civil Law and not by the riparian principle of the Common Law.

The riparian doctrine is not possible of application under all conditions of climate and terrain and, more particularly, in those lands where irrigation is a primary necessity. This doctrine, therefore, in Arizona, Colorado, Idaho, New Mexico, Utah and Wyoming, has given way to the locally recognized rule of prior appropriation which has been written into the several constitutions of these states.

In other states, among which are California, Kansas, Nebraska, North Dakota, South Dakota, Montana, Oklahoma, Texas and Washington, the riparian doctrine of the Common Law has been very substantially modified in its application. Thus, in Kansas, the rule has been enunciated[5] as follows:

> The use of the water of a running stream for irrigation, after its primary uses for quenching thirst and other domestic requirements have been subserved, is one of the common law rights of a riparian proprietor.
>
> The use of water by a riparian proprietor for irrigation purposes must be reasonable under all circumstances, and the right must be exercised with due regard to the equal right of every other riparian owner along the course of the stream.
>
> A diminution of the flow of water over riparian land, caused by its use for irrigation purposes by upper riparian proprietors, occasions no injury for which damages may be allowed unless it results in subtracting from the value of the land by interfering with the reasonable uses of the water which the landowner is able to enjoy.
>
> In determining the quantity of land tributary to and lying along a stream which a single proprietor may irrigate, the principle of equality of right with others should control, . . .

This modified doctrine expresses a rule which is fully as clear and explicit as the original riparian doctrine itself, yet, from the engineering point of view, the qualification[6] of Kent with respect to the latter, namely, that "... all the difficulty that arises consists in the application ..." applies with equal force to the former.

It is of particular interest to note, in this connection, that in the above cited Kansas case the decision quoted the words[7] written as long ago as 1852 by Chief Justice Shaw of Massachusetts as follows:

> The right to the use of flowing water is *publici juris*, and common to all the riparian proprietors; it is not an absolute and exclusive right to all the water flowing past their land, so that any obstruction would give a cause of action; but it is a right to the flow and enjoyment of the water, subject to a similar right in all the proprietors, to the reasonable enjoyment of the same gift of Providence. It is, therefore, only for an abstraction and deprivation of this common benefit, or for an unreasonable and unauthorized use of it, that an action will lie.

For every practical purpose, the above is an explicit exposition of the modified riparian doctrine. It was voiced in one of the original thirteen states and was among the earliest of the American expressions which indicated the inherent limitations of the riparian principle. Even in England as early as 1824, the same limitations were clearly pointed out in *Williams* v. *Morland*,[55] from which a quotation is presented in the references. Likewise in 1851 in another English case, *Embrey* v. *Owen*,[56] which is quoted also in the references.

The foregoing quotations emphasize a sharp line of distinction between the ancient riparian doctrine and the modifications thereof practiced in Kansas and other states. It is as though the absolutism of the original doctrine had been made less harsh and arbitrary and as though no proprietor could complain of any but a substantial injury or one caused by an unreasonable use of the water. To some extent this practice tends toward what often actually occurs under the original doctrine, as in a case where an owner might assert his rights but prefers not to. His failure to complain does not, of course, make the law. He is merely governed by the same considerations which, did he plead his case, the courts would undoubtedly consider. The reasons for this tendency are obvious and are none other than those expressed by Mr. Justice Holmes in the quotation previously given.

The essence of the modified riparian doctrine in the states above enumerated lies in the application of the principle of reasonable use and equitable division to particular cases and the consequent founding in each of them of a body of common law applicable to the natural conditions which prevail. Thus in California, where the riparian doctrine is still constitutionally in effect, the decisions run practically the entire gamut from that of absolute appropriation to the narrowest possible application of the doctrine, as in the comparatively recent case of *Herminghaus* v. *Southern California Edison Company*, 200 Cal. 81. An interesting outline of water rights in California by W. G. Irving, Esq., of the California Bar, appears in the August, 1931, issue of the *Journal of the American Water Works Association*.

This brief outline of the riparian principle has been presented because of the intrinsic bearing of this doctrine on the subject matter of this paper. In the Law, as in Engineering, progress is constantly in the making and,

so far as the flowing waters of the Nation are concerned, it is not too visionary to say that the day is not far distant when title to all of them, subject to but few restrictions, will be in the states as the guardians of the public interest. The example of Oregon in declaring all flowing waters to be public property is indicative of a trend which, as the uses of water increase, will become generally necessary.

The reasons for a trend of this nature were expressed[8] by Mr. Justice Holmes as follows:

> . . . it appears to us that few public interests are more obvious, indisputable, and independent of particular theory than the interest of the public of a state to maintain the rivers that are wholly within it substantially undiminished, except by such drafts upon them as the guardian of the public welfare may permit for the purpose of turning them to a more perfect use. This public interest is omnipresent wherever there is a state and grows more pressing as population grows. It is fundamental, and we are of opinion that the private property of riparian proprietors cannot be supposed to have deeper roots.

The Doctrine of Appropriation.

The principle of prior appropriation has been briefly referred to in the preceding pages. A few further words regarding it are important in order to form a background for the principal subject of this paper.

The doctrine of appropriation is the antithesis of the old Common Law riparian principle and is based on the fundamental concept that, in an arid country, the prosperity and the welfare of the state are absolutely dependent on the employ of water and that the more water can be used the greater will be the public benefit. Under this doctrine, a premium is held out both to the water users and to the owners of lands to which the water can be conveyed.

This principle declares that "beneficial use shall be the basis, the measure and the limit of the right" of the appropriator and that he, who is "first in time shall be first in right." Among the early settlers the diversion of water from a stream and its application to beneficial use were considered to be a right of property. The rights among several appropriators were ranked in the order of their priority, reckoned from the time that the taking of the water was first contemplated, provided that the necessary works were constructed with true diligence. The amount of water to which a right could thus be acquired was limited by the quantity that was beneficially used, and this in turn was generally considered as the capacity of the structures through which the water was taken from the stream.

The essence of the doctrine of appropriation together with a brief outline of its origin, development and recognition is to be found in the opinion[9] in *Basey* v. *Gallagher*, as follows:

> . . . and that he who first connected his labor with the property thus situated and open to general exploration did, in natural justice, acquire a better right to its use and enjoyment than others who had not given such labor; that the miners on the public lands throughout the Pacific states and territories, by their customs, usages, and regu-

lations, had recognized the inherent justice of this principle, and the principle itself was, at an early period, recognized by legislation and enforced by the courts in those states and territories, and was finally approved by the legislation of Congress in 1866.

The principle of prior appropriation is a straightforward recognition that the best interests of a community or district are best served by encouraging the use of water. In this respect the riparian doctrine goes to the opposite extreme and may often be the cause of non-user. Somewhere between these two limits there is a middle ground which, sooner or later, will come to be sanctified by practical reason and adopted as a guiding principle with regard to the waters of interstate rivers. The waters of such streams cannot be rationally viewed from the same angle as those of a river which begins and ends in the domain of a single state where only one law prevails and where a single sovereignty is omnipotent. In all of our broad country, there are relatively few rivers of this character. Most of these are naturally in the seaboard states, except in certain instances in the West where the drainage is into a lake from which water passes by evaporation only. Practically all of the water originating within the territory of the interior states thus becomes interstate or international water as it follows along its ordained paths to the sea.

These considerations indicate the great breadth and extent of the problem of interstate waters. Neither the riparian doctrine nor the principle of appropriation nor any combination of the two is competent to compose differences in cases which involve questions of the rights of states. In such situations the infirmities of both doctrines are manifest. The riparian doctrine of one state cannot extend beyond its boundaries into another and, while the principle of appropriation as a purely theoretical proposition is susceptible of application between states, as indeed it was actually applied in *Wyoming* v. *Colorado*, yet there is a distinct limitation on the extent to which it may safely be used as a guiding precedent. In *Wyoming* v. *Colorado*, Mr. Justice Van Devanter wrote:[10]

> The cardinal rule of the doctrine is that priority of appropriation gives superiority of right. Each of these states applies and enforces this rule in her own territory, and it is the one to which intending appropriators naturally would turn for guidance. The principle on which it proceeds is not less applicable to interstate streams and controversies than to others. Both states pronounce the rule just and reasonable as applied to the natural conditions in that region; and to prevent any departure from it, the people of both incorporated it into their constitutions. It originated in the customs and usages of the people before either state came into existence, and the courts of both hold that their constitutional provisions are to be taken as recognizing the prior usage rather than as creating a new rule. These considerations persuade us that its application to such a controversy as is here presented cannot be other than eminently just and equitable to all concerned.

This controversy between Wyoming and Colorado related to the waters of the Laramie River, a comparatively small stream rising in Colorado and flowing into Wyoming. The decision, above quoted, was strictly predicated

on the doctrine of appropriation under the theory that this doctrine was recognized and practiced by both states, yet it was also said:[11]

> The river, throughout its course in both states, is but a single stream wherein each state has an interest which should be respected by the other.

The effect of the decision, therefore, was to declare that the litigable interests of the two states were interests of the same nature under the doctrine of appropriation, and that an appropriation in either state was valid as against the other. Under the local circumstances, this was a satisfactory conclusion, but in other situations a different solution would be necessary, particularly if each state were firmly held to respect the interest of the other.

It is thus manifest, even under the principle of appropriation, that there is always a sub-stratum of fundamental right in the state which must be distinguished both from the rights of individuals in other states and from those of any other state itself. This basic right of the state is undoubtedly one of the reasons which, within recent years, has led to several interstate compacts and particularly to that which allocated and divided the waters of the Colorado River. In every such case, the underlying and fundamental right of self preservation of the separate states asserts itself and, even though not expressly stated, the provisions of whatever agreement is adopted are written around and about that consideration. It would be an anomalous situation indeed, if appropriations in either the upper or the lower basin of the Colorado River could operate to unequally hamper development in the other. The motive, the necessity and the reason for the Colorado River compact all find their origins in the unspoken assertion of the sovereign right.

Each State May Adopt Its Own Water Doctrine.

Each of the states of the Union, for the control of its own waters, may adopt any rule of law that it may elect. This is one of the settled principles of interstate common law and has many times been reaffirmed by the Supreme Court.

> The states have authority to establish for themselves such rules of property as they may deem expedient with respect to the streams of water, within their borders both navigable and non-navigable, and the ownership of the lands forming their beds and banks. *U. S.* v. *Cress*, 243 U. S. 316, 319.

> As to every stream within its dominion a state may change the common law rule and permit the appropriation of the flowing waters for such purposes as it deems wise. *U. S.* v. *Rio Grande Irrigation Company*, 174 U. S. 690, 702.

> It (the state) may determine for itself whether the common law rule in respect to riparian rights or that doctrine which obtains in the arid regions of the West of the appropriation of waters for the purposes of irrigation, shall control. Congress cannot enforce either rule upon any state. *Kansas* v. *Colorado*, 206 U. S. 46, 94.

Also in *Hardin* v. *Jordan*, 140 U. S. 371, 381, 382, the Court said:

> This right of the states to regulate and control the shores of tide waters, and the land under them, is the same as that which is exercised by the Crown in England. In this country the same rule has been extended to our great navigable lakes, which are treated as inland seas; and also, in some of the states, to navigable rivers, as the Mississippi, the Missouri, the Ohio, and, in Pennsylvania, to all the permanent rivers of the state; but it depends on the law of each state to what waters and to what extent this prerogative of the state over the lands under water shall be exercised.

Within its own boundaries, each state has perfect freedom of action, even to the extent of preventing the export of its waters. This important principle was distinctly expressed by Mr. Justice Holmes in the words:[12]

> We are of opinion, further, that the constitutional power of the state to insist that its natural advantages shall remain unimpaired by its citizens is not dependent upon any nice estimate of the extent of present use or speculation as to future needs. The legal conception of the necessary is apt to be confined to somewhat rudimentary wants, and there are benefits from a great river that might escape a lawyer's view. But the state is not required to submit even to an æsthetic analysis. Any analysis may be inadequate. It finds itself in possession of what all admit to be a great public good, and what it has it may keep and give no one a reason for its will.

Every state is limited in area, and the lines which bound its physical extent also delimit its doctrines of law. The waters of a river, however, recognize no man-made law nor any boundary erected by him. Under the compelling force and unamendable law of gravity, they flow across his arbitrary political lines from the jurisdiction of one sovereignty into that of another. In one state the old riparian doctrine may be in full force and effect, while in another the theory of appropriation may be the guiding principle. How then, in the absence of any constitutional Federal law, may differences between states with respect to water flowing first in one and then in the other be composed? This question naturally brings us to a consideration of the principles of law that govern the waters of interstate streams. The Supreme Court of the United States is the only tribunal empowered under the Constitution to determine disputes between the states, and the binding law of interstate waters is to be found only in its decisions.

The Settlement of Disputes Between States.

The interstate law of waters is that branch of the Common Law which deals with matters relating to the waters of interstate streams. The principles on which this law is based can be declared only by the Courts of the United States, and the final word is with the Supreme Court. Differences arising between the states of the Union with respect to interstate waters may be composed in two ways. First, by agreement, in which case the legislatures of the interested states, with the approval of Congress, may adopt a compact and thus bring into being a "compact law" applying locally within a stated territory and to the subjects specifically set forth. Such a

law is higher than any local laws of the states adopting it and may be finally interpreted only by the Supreme Court of the United States.

Under the second procedure, a controversy in regard to interstate waters, wherein a state is a party, can be determined only by litigation in the Supreme Court of the United States acting under its original jurisdiction. Questions relating to interstate waters may also come before the Supreme Court in the form of appeals from decisions of the lower Federal courts, in cases where an individual or corporation of one state may seek redress for acts committed in another state.

The first case of high importance between two state sovereignties in which the question of rights with respect to the quantity of flow in an interstate stream stood as the paramount issue was that of Kansas against Colorado.[13] The original arguments were made in 1902, and the Court then decided that the matter should be referred to a Master for the taking of proof. Arguments were again heard in 1906, and the final decision was handed down on May 13, 1907.

Since that time, a number of other decisions have been rendered in similar cases, so that the principles of law relating to interstate waters are now well understood and there is in existence a substantial body of interstate common law on this subject. The two most recent cases, both decided in 1931, were those of *Connecticut* v. *Massachusetts*[14] and *New Jersey* v. *New York and the City of New York*.[15] The decision in each of these cases is so clear-cut and emphatic that few states will hereafter risk the outcome of a trial unless, indeed, agreement on a compact is impossible. So is the prophesy[16] of Mr. Justice Baldwin in 1838 coming to be realized. He wrote:

> Bound hand and foot by the prohibitions of the Constitution, a complaining state can neither treat, agree, or fight with its adversary, without the consent of Congress. A resort to the judicial power is the only means left for legally adjusting or persuading a state which has possession of disputed territory to enter into an agreement or compact relating to a controverted boundary. Few, if any, will be made when it is left to the pleasure of the state in possession; but when it is known that some tribunal can decide on the right, it is most probable that controversies will be settled by compact.

Interstate Compacts.

The most direct and satisfactory means for composing difficulties between the states, with respect to waters in which they have distinct interests, is by the adoption of a compact and its approval by the Congress. Every such compact must necessarily be a compromise; yet the principles of Justice and Equity are of such potent force and effect that practically every group of responsible commissioners, assisted by competent counsel and furnished with sound engineering advice, will find no rationally insuperable difficulty in arriving at a conclusion which is both immediately and prospectively fair to all parties concerned. The determination of the principles to be incorporated in a compact is thus readily arrived at but, at this point,

obstacles to further progress usually make their appearance. To become effective, a compact must be approved by the legislatures of the states, and so, after it has been ratified by the compact commissions, it emerges into a field where considerations of political expediency are paramount and where every conceivable type of argument may be advanced against it. In the case of the Delaware River, two forms of compact were unanimously agreed upon by the commissions representing New York, New Jersey and Pennsylvania; yet neither of them was finally consummated. Both of these failures were wholly political in nature, and neither of them was related to the subject matter of the documents themselves.

On the other hand, a substantial number of compacts have been successfully consummated; the most prominent example of these is that agreed to by the states of the Colorado River Basin. Negotiations looking toward this compact led to the unanimous agreement of the authorized commissions and to its final adoption by the legislatures of Colorado, Wyoming, New Mexico, Utah, Nevada and California. In the Arizona legislature, however, the concurring legislation was defeated by a single vote. Subsequent action by Congress authorized this agreement and made it effective as a six-state compact. Arizona thereupon brought suit in the Supreme Court of the United States to enjoin the Secretary of the Interior from proceeding with the construction of the Hoover dam and the Boulder Canyon reservoir, and also sought to enjoin the other six states from any action under this compact as Congress had approved it.

After answer had been made, the Court considered the complaint and the answers upon the motion of the defendants to dismiss and, taking judicial notice of the well-known facts of the case, dismissed the action without prejudice to Arizona's later plea for relief if, and when, it might be shown that she would be damaged or injured. The decision[17] in this case, written by Mr. Justice Brandeis, is a masterpiece and should be in the library of every engineer interested in the legal status of the waters of the United States. Mr. Justice Brandeis clearly pointed out that Arizona's position in not joining with the other states could not deprive her of any right she would have had in the absence of the six-state compact, and Arizona therefore stands exactly in the position which she occupied in common with the other states before the compact was consummated. They must not interfere with Arizona or damage her but, as she has chosen to remain independent, they may benefit more than she. Arizona's position is that of a sovereign. No reason could be asked of her, and no Court could question her determination. Such matters are only to be composed by time in its passage, and the wisdom of Arizona's choice must be left for the future to disclose.

The Law of Interstate Waters.

The governing principles of law in cases relating to interstate waters are a branch of the interstate common law which is being built up by the

decisions of the Supreme Court in cases of dispute between the states. In *Kansas* v. *Colorado*, 206 U. S. 46, 98, Mr. Justice Brewer wrote:

> . . . through these successive disputes and decisions this Court is practically building up what may not improperly be called interstate common law.

Without going into extended detail and without unduly lengthening this paper the most important of the governing principles are the following:

First:

Before this Court can be moved to exercise its extraordinary power under the Constitution to control the conduct of one state at the suit of another, the threatened invasion of rights must be of serious magnitude, and it must be established by clear and convincing evidence. *New York* v. *New Jersey*, 256 U. S. 296, 309.

In such action by one state against another, the burden on the complainant state of sustaining the allegations of its complaint is much greater than that imposed upon a complainant in an ordinary suit between private parties. *North Dakota* v. *Minnesota*, 263 U. S. 365, 374.

Before this Court ought to intervene the case should be of serious magnitude, clearly and fully proved, and the principle to be applied should be one which the Court is prepared deliberately to maintain against all considerations on the other side. *Missouri* v. *Illinois*, 200 U. S. 496, 521.

Second: In *Wyoming* v. *Colorado*, 259 U. S. 419, 464, Mr. Justice Van Devanter wrote:

On full consideration it was broadly determined that a controversy between two states over the diversion and use of waters of a stream passing from one to the other "makes a matter for investigation and determination by this court," in the exercise of its original jurisdiction, and also that the upper state on such a stream does not have such ownership or control of the waters flowing therein as entitles her to divert and use them regardless of any injury or prejudice to the rights of the lower state in the stream. And, on consideration of the particular facts disclosed and the local law of the two states, it was determined that Colorado was not taking more than what, under the circumstances, would be her share under an equitable apportionment.

Third: In *Connecticut* v. *Massachusetts*,[14] Mr. Justice Butler wrote:

But the laws in respect of riparian rights that happen to be effective for the time being in both states do not necessarily constitute a dependable guide or just basis for the decision of controversies such as that here presented. The rules of the common law on that subject do not obtain in all the states of the Union, and there are variations in their application. The doctrine of appropriation prevails in some states. And every state is free to change its laws governing riparian ownership and to permit the appropriation of flowing waters for such purposes as it may deem wise. *United States* v. *Rio Grande Irrigation Co.*, 174 U. S. 690, 702.

For the decision of suits between states, federal, state and international law are considered and applied by this Court as the exigencies of the particular case may require. The determination of the relative rights of contending states in respect of the use of streams flowing through them does not depend upon the same considerations and is not governed by the same rules of law that are applied in such states for the solution of similar questions of private right. *Kansas* v. *Colorado*, 185 U. S. 125, 146. And, while the municipal law relating to like questions between individuals is to be taken into

account, it is not to be deemed to have controlling weight. As was shown in *Kansas* v. *Colorado*, 206 U. S. 46, 100, such disputes are to be settled on the basis of equality of right. But this is not to say that there must be an equal division of the waters of an interstate stream among the states through which it flows. It means that the principles of right and equity shall be applied having regard to the "equal level or plane on which all the States stand, in point of power and right, under our constitutional system" and that, upon a consideration of the pertinent laws of the contending states and all other relevant facts, this Court will determine what is an equitable apportionment of the use of such waters. *Wyoming* v. *Colorado*, 259 U. S. 419, 465, 470.

Fourth: In *New Jersey* v. *New York and the City of New York*,[15] Mr. Justice Holmes wrote:

We are met at the outset by the question what rule is to be applied. It is established that a more liberal answer may be given than in a controversy between neighbors members of a single state. *Connecticut* v. *Massachusetts*, February 24, 1931. Different considerations come in when we are dealing with independent sovereigns having to regard the welfare of the whole population and when the alternative to settlement is war. In a less degree, perhaps, the same is true of the quasi-sovereignties bound together in the Union. A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it. New York has the physical power to cut off all the water within its jurisdiction. But clearly the exercise of such a power to the destruction of the interest of lower states could not be tolerated. And on the other hand equally little could New Jersey be permitted to require New York to give up its power altogether in order that the river might come down to it undiminished. Both states have real and substantial interests in the river that must be reconciled as best they may be. The different traditions and practices in different parts of the country may lead to varying results but the effort always is to secure an equitable apportionment without quibbling over formulas. See *Missouri* v. *Illinois*, 200 U. S. 496, 520. *Kansas* v. *Colorado*, 206 U. S. 46, 98, 117. *Georgia* v. *Tennessee Copper Co.*, 206 U. S. 230, 237. *Wyoming* v. *Colorado*, 259 U. S. 419, 465, 470. *Connecticut* v. *Massachusetts*, February 24, 1931.

This case was referred to a Master and a great mass of evidence was taken. In a most competent and excellent report the Master adopted the principle of equitable division which clearly results from the decisions of the last quarter of a century. Where that principle is established there is not much left to discuss. The removal of water to a different watershed obviously must be allowed at times unless states are to be deprived of the most beneficial use on formal grounds. In fact it has been allowed repeatedly and has been practiced by the states concerned. *Missouri* v. *Illinois*, 200 U. S. 496, 526. *Wyoming* v. *Colorado*, 259 U. S. 419, 466. *Connecticut* v. *Massachusetts*, February 24, 1931.

Fifth: The Court will not consider or determine abstract questions relating either to future rights in, or future uses of, water. Thus the Court, in *New York* v. *Illinois*, 274 U. S. 488, held:

The suit is one for an injunction, a form of relief which must rest on an actual or presently threatened interference with the rights of another. . . . We are not at liberty to consider abstract questions.

Also in *Arizona* v. *California et al*,[17] Mr. Justice Brandeis wrote:

There is no occasion for determining now Arizona's rights to interstate or local waters which have not yet been, and which may never be, appropriated. *New Jersey* v. *Sargent*, 269 U. S. 328, 338. This Court cannot issue declaratory decrees.

These five commandments are at the bottom of all the law and constitute the basis of its application. Interstate waters are subject to equitable apportionment and division, and the equities are to be determined by the Court after the taking of evidence and the hearing of argument. There is, however, one further principle which was stated by Mr. Justice Brewer in *Kansas* v. *Colorado*, 206 U. S. 46, 109, and which has not been referred to in any subsequent decision. This principle is to the effect that before the Court can be moved to action it must be shown that the complaining state ". . . has not merely some technical right, but also a right with a corresponding benefit."

The above-stated principles condense the law of interstate waters into the smallest practicable compass. The fundamentals of this law are sound from nearly every point of view. They are, however, based only on considerations of abstract equity, and a determination in any particular case requires the weighing of evidence almost wholly on the question of whether the act complained of threatens injury and damage of serious magnitude. For the injury of serious magnitude there is neither definition nor criterion, and the tendency has been to minimize the fundamental and sovereign rights of the states and to magnify, as under the riparian doctrine, the rights of individuals. This tendency of course is perfectly natural, because it is always difficult to break with the precedents of an old order and to embark on a new. In this respect, the law will undoubtedly come to be revised to the end that more perfect justice may be done in the more important cases that will hereafter arise. In the following paragraphs the author will point out the particulars in which he believes the law as it now stands, falls short of that which will hereafter prevail.

The Rights of the States.

At the close of the American Revolution, the thirteen original colonies secured their independence, and each became a sovereign nation. Thereafter these colonies, in the Articles of Confederation and later under the Constitution of the United States, "in order to form a more perfect Union," relinquished certain fractions of their absolute sovereignty. Among the fractions surrendered by all of the states was that which conferred upon the Federal Government the power to regulate navigation, but the right to use its own waters for all other purposes was retained by each of the states as by a sovereign nation.

The Revolution devolved on each state the prerogative of the King as he had held it in the Colonies, 12 Pet. 751.

When the Revolution took place the people of each State became themselves sovereign, and in that character hold the absolute right to all their navigable waters, and the soil under them for their own common use, subject only to the rights since surrendered by the Constitution to the General Government. *Martin* v. *Waddell*, 16 Pet. 367, 410, cited in *Gilman* v. *Philadelphia*, 8 Wall. 713, 726.

From the close of the Revolution then, down to the present time, each riparian proprietorship in the waters of an interstate stream, within the original thirteen colonies, has been subordinate to the superior rights of those state sovereignties which are located above it. No other conclusion seems possible. The riparian owner on an intra-state stream, under the treaty of Paris, became amenable to the authority of the sovereignty in which he was located. Similarly with the riparian owner on an interstate stream, but, by the same token, his rights in the waters of that stream were circumscribed by the inherent rights of the sovereignties within which the waters of his stream originated or through which they passed on their way down to his lands. His individual rights must, therefore, at the very least, be limited equally as much as those of his own sovereign for, as Mr. Justice Holmes said:[18]

> . . . the state has an interest independent of and behind the titles of its citizens, in all the earth and air within its domain.

The same situation undoubtedly holds for all of the other states since they were admitted to equal rank in the Union and endowed with equal rights and privileges. Mr. Justice Brewer wrote:[19]

> While arid lands are to be found mainly, if not only, in the Western and newer states, yet the powers of the national government within the limits of those states are the same (no greater and no less) than those within the limits of the original thirteen; and it would be strange if, in the absence of a definite grant of power, the national government could enter the territory of the states along the Atlantic and legislate in respect to improving, by irrigation or otherwise, the lands within their borders. Nor do we understand that hitherto Congress has acted in disregard to this limitation.

With respect to navigation, the power of the Federal Government transcends that of the states and rises far above that of any riparian owner, while with regard to the reasonable use of interstate waters by any upper state sovereignty, for purposes other than navigation, no riparian owner can find objection, because his holding has always been subject to the superior rights of the sovereignties on the river above him. These sovereign rights were in existence before his, and his were always inferior and subservient to them. Thus does the quality of riparian ownership on an interstate stream differ from that on one which is intra-state. Consider for a moment a riparian owner on the Connecticut River just south from the Massachusetts border. His right is subject to the direct power and jurisdiction of Connecticut, but it is also, and has always been, subject to the rights of each of the sovereignties of Vermont, New Hampshire, Massachusetts and the Dominion of Canada. And while this owner for many years may have enjoyed and used the full flow of that river, he is not, because of this fact, entitled to complain when an upper sovereignty moves to the exercise of its right. He has merely been using and deriving benefit from something that was never his and to which he could never acquire title.

In *Cohen* v. *U. S.*, 162 Fed. 364, 370, the Court said:

> The riparian owner cannot have a present vested right to that which does not exist, and which may never have an existence.

A state cannot lose its sovereign right because of non-user; neither can another state or an individual riparian owner acquire title by prescription against a sovereign state. This principle was clearly indicated in *Rundle* v. *Delaware and Raritan Canal Co.*, 14 How. 80, 93, where the Court said:

> Nor can the plaintiff claim by prescription against the public for more than the act confers on him, which is at best impunity for a nuisance. His license, or rather toleration, gives him a good title to keep up his dam and use the waters of the river, as against every one but the sovereign, and those diverting them by public authority, for public uses.

Riparian rights along an interstate stream are limited and qualified in the same manner and to the same extent as are those along an international stream. Each state or nation, having always had the right to use the waters of such a stream, may proceed to the exercise of that right whenever it wills, and such action can do no damage or injury to any individual in anything as to which he has ever had title or interest, it being provided, however, that no upper state can go beyond a reasonable use. Each state owes an unwritten duty to all the others.

In other words, it seems certain, beyond peradventure, that there resides in every state a basic right to use a substantial part of the water which comes into being upon its own soil and flows thence into an interstate stream. A right of this nature is among the most fundamental of the attributes of sovereignty. As a matter of pure law, this consideration may be ignored in some situations and no harm be done while, on the other hand, as a matter of practical engineering, grave injustice will result in many cases, if the lower state is always to be continued in the generally preferential position it now occupies. The rights of private property to, and in, the waters of an interstate stream cannot be held to be so absolute as those of similar property wholly under a single sovereign. All such ownerships must recognize that their titles are limited and qualified and that their use of the waters on which they front may sooner or later have to be shared with the sovereignties situated higher up on the stream.

The probable future trend of interstate water law thus seems likely to be in the direction of a broader definition of the expressions "equitable division" and "equitable apportionment," coupled with a more explicit recognition of the rights of the states and a subordination of those of individual owners. As between the states, their rights and their obligations are correlative and reciprocal. The engineer, in planning any new development on an interstate stream, should, therefore, so shape his plan that it will withstand both the scrutiny of reason and the judicial determination as to whether its proscription will do greater violence to any state sovereignty than will its approval.

The Case of the Delaware River.

In July, 1927, the Board of Water Supply of the city of New York recommended a plan for a new supply of water from five tributaries of the Delaware River lying wholly within the state of New York. This plan was approved by the city's governing board, the Board of Estimate and Apportionment, on January 12, 1928 and by the Water Power and Control Commission of the state of New York on May 25, 1929.

On May 13, 1929, the state of New Jersey filed its Bill of Complaint in the Supreme Court of the United States against the state and city of New York, and the defendants made answer on May 27, 1929.

On December 9, 1929, the Commonwealth of Pennsylvania sought leave to intervene *pro interesse suo*, and this request was granted by the Court provided that the Commonwealth would file a statement of its interest and the relief desired. This statement was filed on February 10, 1930.

In the meantime the state of New Jersey moved that the case should be set down by the Court for hearing "on Bill and Answer" which means that the Court was requested to proceed to a final consideration of the case on the complaint of New Jersey and the several New York answers. Under this procedure the taking of testimony would have been dispensed with and the case greatly shortened; but when it was discovered by New Jersey on January 20, 1930, that, under its request, the Court could proceed only to a final determination, the motion was withdrawn.

Finally on January 27, 1930, the Court appointed the Honorable Charles N. Burch of Memphis, Tennessee, as Special Master to take evidence and make findings of fact and conclusions of law and to report them with all convenient speed together with his recommendations for a decree.

The taking of testimony was begun on April 21, 1930, and concluded on September 19. Altogether 43 days were spent in Court and six days on a field inspection. Oral argument before the Special Master was had on November 17 to 20. The Special Master's Report was filed on February 2, 1931; final argument before the Supreme Court was heard on April 14 and 15, 1931; the decision was handed down on May 4 and the decree entered on May 25, 1931, — just two years and 12 days after the complaint of New Jersey was entered.

The Plan of New York City.

This plan contemplated the building of reservoirs on each of five non-navigable tributaries of the Delaware River lying wholly within the state of New York and the diversion from them of a quantity of water not to exceed a yearly average of 600 m.g.d. The plan provided for the release of water from these reservoirs whenever the natural flow in the tributaries should fall below the "ordinary flow," which was defined as a flow of 0.45 c.f.s. per sq. mile and, under this condition, a flow of that same amount would be released. Whenever the flow was greater than the ordinary flow,

then all of the water would be conserved and, most important of all, the plan further provided that a flow equal to the ordinary flow would always, and under all conditions, be released on every day of July, August, September and October.

The plan, therefore, was essentially one of storing flood waters, while at the same time it guaranteed to all of the river below that the summer conditions would be substantially improved during the driest of seasons, although during wet summers there would be a slight diminution, which condition, however, would not occur unless the river was running at more than the ordinary flow.

This rule of release was voluntarily adopted by the city of New York and presented as part of its plan, because it had been agreed upon and adopted by two separate compact commissions from the three interested states and was the outstanding feature of the compact negotiations which began in 1924 and continued to 1927.

For the purposes of this discussion, the accompanying outline map shows the main features of the general situation in sufficient detail, and the following tabulation presents the main watershed areas:

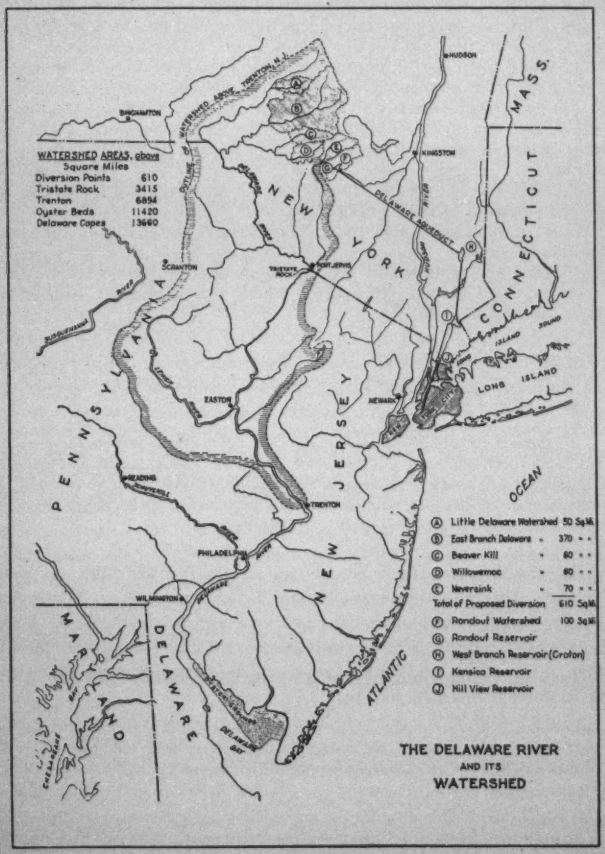
Watershed.	*Square Miles.*
Five tributaries to be diverted	610
In New York above Tri-State Rock	2 389
In Pennsylvania above Tri-State Rock	1 016
In New Jersey above Tri-State Rock	10
Total above Tri-State Rock	3 415
In New York above Trenton	2 389
In Pennsylvania above Trenton	3 470
In New Jersey above Trenton	1 035
Total above Trenton	6 894
Total above the Oyster Beds in Delaware Bay	11 420
Total above the Delaware Capes	13 660

The above figures show that the area from which diversion was proposed is 25.5 per cent. of the area in the state of New York; 17.8 per cent. of the area above Tri-State Rock; 9.0 per cent. of the area above Trenton and 5.3 per cent. of the area above the oyster beds. These figures indicate clearly the extent and general effect of the plan, particularly when the provisions for the release of water and the limitation as to the total quantity to be taken in any year are kept in mind. In this connection, it is also important to note that the average annual water yield per square mile of the several different parts of the Delaware drainage area, from the best records available, is as follows:

Above the area to be diverted	2.20 c.f.s.
Above Tri-State Rock	1.84 c.f.s.
Above Trenton	1.69 c.f.s.

The above is a very brief outline of the plan and of the main hydrographic features of the Delaware area. The city of New York based its

plan squarely on the agreements reached by the compact commissions to the extent of the limited quantity of water to be taken, namely 600 million gallons daily, as in the compact form of 1927, and with the reserve flow



provisions that had twice been adopted. Nevertheless, the state of New Jersey filed its suit as has already been outlined.

The Complaint of New Jersey.

The New Jersey Bill of Complaint alleged that the plan of New York was unlawful in the following general particulars:

(1) That New Jersey would be deprived of the natural advantages of its position.

(2) That the diversion proposed was contrary to the principles of the riparian doctrine of the Common Law as well as to the decisions in the three states and would, moreover, transfer water from one watershed to another.

(3) That the carrying out of the plan would create a preference in favor of the Port of New York over ports on the Delaware River.

(4) That the plan, if permitted, would impose upon New Jersey a system of division and appropriation of the Delaware waters and that no such system could be made effective except through an interstate compact.

(5) That the effect of the plan would be to take property without due process of law in violation of Article XIV, Section I, of the Federal Constitution.

(6) That the plan would interfere with and regulate interstate commerce, in violation of the Constitution.

(7) That the plan would violate the Federal Water Power Act and the amendments thereto.

(8) That the plan would constitute an obstruction to the navigable capacity of the Delaware River, for which the affirmative authority of Congress would be necessary.

On these grounds and because of alleged damage and injury that would result in many particulars, which will be discussed later, New Jersey prayed[20] that the Court should issue its injunction against

> . . . the said state of New York and the city of New York, perpetually restraining and enjoining them, and each of them, their respective officers, agents and employees, and all other persons acting or claiming or assuming to act under their, or either of their, authority from diverting or abstracting any waters from the Delaware River or from any of its tributaries . . . or of any part . . . of them.

This was the rule which New Jersey sought to have the Court adopt and apply. This rule, of course, if established against New York, would have been equally binding on Pennsylvania and on New Jersey herself. Such an exceedingly narrow construction would have been detrimental to all three of the states, and the Commonwealth of Pennsylvania pointed out in her Statement of Interest[21] that:

> Application of the principles set forth in New Jersey's bill of complaint would prevent the future development and use of the Delaware River or its tributaries above the head of tide water as a source of water supply to the city of Philadelphia and/or other municipalities, cities, towns, villages and communities contiguous to the Delaware River.

Throughout the trial of this case the representatives of the Commonwealth of Pennsylvania stood firmly on the fundamental principles which had twice been subscribed to by the plenipotentiaries of that state in the negotiations which led to the unanimous adoption of two compact forms by the negotiating commissions of the three states. In this case these principles were stated[22] as follows:

> . . . the question as the Commonwealth of Pennsylvania conceives it being not one of prior appropriation, but of a just and equitable allocation, having in mind not only

the present but the reasonable future needs of all the states interested in the waters of the Delaware River and its tributaries.

At all stages of the trial the representatives of the Commonwealth of Pennsylvania were keenly alert to determine (1) whether the plan of New York contemplated a proper release of impounded flood waters for the purpose of increasing the low-water flows of the Delaware, and (2) whether the proposed plan would work material damage to any present or future Pennsylvania interest. They recognized the vital importance to their Commonwealth of a decision which would be in the form of a present allocation and which would not prejudice any possible future interest. To them the fundamental right of each of the states in these waters was paramount, because the Delaware River by virtue of its location will inevitably come to be one of the major sources of water supply in the great New York — New Jersey — Pennsylvania metropolitan area.

The position taken by Pennsylvania looked broadly to the future and was in marked contrast to that of New Jersey, which viewed the case from the aspects of the past and without regard to the progress of civilization. On the main issues of the case, therefore, Pennsylvania as a lower state and New York as an upper state stood side by side. Only on minor matters did differences of opinion appear, and all such were easy of adjustment. The interests of Pennsylvania along the Delaware River are, at the very least, greater than those of New Jersey; yet the viewpoints of the states were poles apart. New Jersey would have had it that no one should use any Delaware water, while Pennsylvania held that each interested state should have the right to use it reasonably under a fair and equitable allocation. The just position taken by Pennsylvania undoubtedly influenced the final outcome of the case and, when its history comes to be written, the engineers of the future, including those of New Jersey, will freely acknowledge their indebtedness to those brethren of their profession who held up the hands of the Commonwealth's counsel and thus made possible a long step forward toward a better understanding of the principles underlying the law of interstate waters.

The New York Plan Modified by the Special Master.

The Special Master, in arriving at his conclusions, predicated them on a modification of the New York plan, and it is, therefore, important, at this stage, to note the changes which he recommended.

The original plan looked to the taking of 600 m.g.d. as a yearly average. This quantity, the Special Master reduced to 440 m.g.d., and the original plan of release, previously stated, was changed to what was called the Pennsylvania plan of release. The latter follows:

Whenever the flow in the Delaware at either or both Port Jervis or Trenton, falls below 0.50 c.f.s. per sq. mile of tributary drainage area, then water shall be released by New York in sufficient volume to bring the flow

at these places up to 0.50 c.f.s. per sq. mile, it being provided, however, that the maximum rate of discharge from the reservoirs shall not exceed 0.66 c.f.s. per sq. mile of drainage area above them.

The Master also recommended:

That before any diversion is made, the sewage of Port Jervis, New York, shall be treated so as to effect a reduction of 85 per cent. in organic impurity and that the effluent be sterilized so as to reduce the *B. coli* originally present in the sewage by 90 per cent.

With this understanding of the modifications which were ordered in the plan, it is possible to proceed with the consideration of the contentions which were set up against it and the Master's conclusions as to each.

The Decision As to the General Allegations of the New Jersey Complaint.

Considering the several general items (previously enumerated) of the New Jersey complaint, the Special Master made the following findings:

(A) The plan of diversion as herein modified will not operate to take the property of New Jersey and its people without due process of law in violation of the Fourteenth Amendment of the Constitution, or to regulate commerce among the states in violation of Article I, Section 8, of the Constitution or to prefer the ports of New York to the ports of New Jersey, in violation of Article I, Section 9 of the Constitution.[23]

(B) The carrying out of the New York diversion will not be in violation of the Federal Water Power Act.[24]

(C) In suits between states (heretofore decided by this Court) relative to the diversion of waters, there has been built up a system of law denominated as "interstate common law," and under principles of interstate common law, the rule of fair and equitable apportionment is to be applied under the facts of this case rather than the common law rule of riparian rights.[25]

(D) The Delaware River is a stream in which New York, New Jersey and Pennsylvania have a common interest and no one state is entitled to a monopoly of the stream or to such excessive use or enjoyment of the stream or its tributaries as would cause unreasonable injury to the other states.[26]

These four findings of the Master completely disposed of the eight general allegations which had been advanced by New Jersey as reasons why the taking of any water should be denied.

New Jersey's Pleas of Lack of Justification.

The complaint of New Jersey also alleged that New York was not justified in presenting its plan for diverting water from the Delaware River for the following reasons:

(1) That New York's present use of water is unnecessary and wasteful and that by the installation of universal metering much could be saved. In the words of the complaint — "Equity requires the conservation and economical use of the City's water supply before it can (if it ever can) invade the rights and privileges of the plaintiff . . . and

thereby destroy or impair the vested legal rights of . . . its citizens in the flow of said river."[27]

(2) That there are other sources of water supply available to New York and that these should be used " . . . without the invasion of any watershed or supplies affecting the plaintiff or any other state . . ."[28]

(3) That there is no public necessity for the proposed diversion of waters by said city from the tributaries of the Delaware River.[29]

(4) That the city of New York not having changed its water rates since 1856 and earning a profit on its water systems now proposes to take Delaware water to be sold at a profit to itself and to the great damage of New Jersey.

(5) That New Jersey is a rapidly growing commonwealth and "That the proposed diversion . . . will deprive plaintiff and its citizens of water which they are legally entitled to have and use for domestic, potable and industrial uses."[30]

These several matters were disposed of by the Special Master in his findings previously quoted and in those which follow:

(A) In the enjoyment of common property each state must yield something to other states, so that such other states may have their fair enjoyment of the common property.[31]

(B) The New York tributaries of the Delaware furnish the best and purest source of additional water supply for New York City, the most satisfactory supply and the most economical supply.[32]

(C) New York City, acting under the authority of New York State, should have the right to select its source of water supply. This is a matter which concerns the administration of its own internal affairs and should not be controlled by another state unless its plan for additional water supply is willful or arbitrary and without sound basis and unreasonably injures such other state.[33]

(D) The selection of the tributaries of the Delaware is not an arbitrary one and without sound reason, as the tributaries of the Delaware furnish the best and purest water available and the supply of water from that source is furnished by gravity . . . and is the least expensive, though the matter of expense is not as controlling with the Special Master as the other considerations.[34]

(E) Likewise it seems to me that it is a matter entirely for the determination of the city of New York as to what rates shall be charged for the delivery of water to consumers thereof and also whether the best interests of the city and its water consumers are conserved by a system of universal metering or by some other system.[35]

(F) I think the proof also fairly shows that the expense of obtaining water from the Delaware River watershed is less than the expense of obtaining an equal quantity of water from the other sources suggested by the plaintiff and that the state of New York and the city of New York have not selected the tributaries of the Delaware River arbitrarily and without reason.[36]

Thus, under the application of the principles of interstate common law, did the Special Master dispose of all of New Jersey's legal and argumentative contentions. It having been found that the rule of "fair and equitable apportionment" was applicable in this case, the background was at once established, and it remained only to examine the facts to determine how, and to what extent, the operation of the plan of the city of New York would tend to injure the rights and interests of New Jersey. Pennsylvania did not object to New York's proposal to use 600 m.g.d. even though her interests with respect to damage were identical in kind and greater in ex-

tent than those of New Jersey, except as to the oyster beds in the latter. Pennsylvania, however, was insistent that her plan of release should be adopted, and as already stated the Special Master agreed with that contention. It now remains to examine the allegations of injury and damage. This will be done by briefly stating each of them, by very shortly discussing the proof and by quoting the conclusions of the Special Master.

New Jersey's Allegations of Injury and Damage.

Navigation. On this point, much testimony was adduced to show that the Delaware is a navigable stream, even in its upper reaches where the proposed dams are to be located. The Special Master found that, while the Delaware may be considered a navigable stream, the tributaries are not navigable. The scope of the findings was thus limited, as a practical matter, to determining the effect of the plan on the navigable capacity of the river. On this point the Special Master called as his own witness General George B. Pillsbury, Assistant Chief of Engineers, and, on the basis of his testimony, which New Jersey, without success, endeavored to rebut, reported:

> There was evidence to the contrary by a number of witnesses, though . . . (one of them) . . . stated, when introduced as a witness by New Jersey, that in a general way he agreed with most of the statements of General Pillsbury and that General Pillsbury's evidence was possibly correct if properly interpreted. I am of the opinion that General Pillsbury's evidence is too clear to need interpretation. Interpretation would not clarify, for it is already clear.
>
> I am, therefore, of the opinion that there is no basis for injunctive relief on the part of New Jersey on the ground that the carrying out of the New York plan would obstruct navigation or impair the navigable capacity of the Delaware River.[37]

Water Power. The New Jersey complaint under this head alleged that the proposed diversion of water ". . . will forever destroy the opportunity for the feasible commercial development of all, or a considerable proportion, . . . in excess of 350 000 horsepower (firm power) . . . of a net value in excess of 18 million dollars per year. . . ."[38]

Water power on the Delaware River has, for many reasons, never been a success, and there is not now a single dam across its channel for this purpose. On the tributaries, however, there are a number of power developments. Reference to the map will show that the Delaware, for most of its length, is a stream forming the boundary between two states.

The experts for New Jersey envisaged a gigantic power development for the Delaware River with three great storage reservoirs wholly within the state of New York, with eleven dams across the river between Pennsylvania and New York, with eleven others between Pennsylvania and New Jersey, together with seven additional developments on tributaries in New York and Pennsylvania. This entire system was proposed to be operated as a harmonious and coördinated whole for the purposes of navi-

gation and water power as well as to furnish, at short notice, great volumes of water to reduce the salinity in Delaware Bay and thus control the salt-water enemies of the oysters. This latter function was introduced as an afterthought when it was realized that this great comprehensive power development would more profoundly affect New Jersey's own oysters than would anything that New York could possibly do. The reduction of the salinity in Delaware Bay by the release of large volumes of stored water, as proposed, introduced an element of great uncertainty and one entirely inconsistent with the development of water power.

On paper, New Jersey unhesitatingly invaded the territory of both her neighbors and laid out her plan for water power but failed to show any organization, scheme or outline for its accomplishment. Under these circumstances, this visionary plan made little headway, though it was strongly advocated over many pages of testimony and by scores of exhibits accompanied by estimates of cost which purported to show that New Jersey's share of the values which such a plan would create was $2 500 000. These figures were the product of ingenious and wholly theoretical computations which served only to confuse the issue by contradiction and by implication that the state of New York was, in some vague way, obligated to contribute its natural storage possibilities in order to create this value in New Jersey and that, if such value were thus brought into being, the state which made the development possible should be enjoined from using the water for any other purpose.

Further discussion of this water-power claim is unnecessary. The Special Master found that:

> No injunctive relief can be granted on the ground of the alleged damage to New Jersey's water power rights in the Delaware, as there is no definite or authorized project for damming the Delaware River to create water power, and before any such project could be carried out, it would be necessary to obtain (1) the consent of Congress, (2) the consent of Pennsylvania and New Jersey for dams across the river between Pennsylvania and New Jersey, and (3) the consent of Pennsylvania and New York for dams crossing the river between those states. No one has applied for such consent and the evidence indicates that such consent would not be obtained. In determining whether injunctive relief should be granted, the law looks to the immediate and the proximate, and not to the remote.
>
> It is a contested question of fact whether the comprehensive plan of power development suggested by New Jersey, though feasible from an engineering standpoint, would be economically sound and such as to yield a fair return on the investment. New Jersey has failed to establish by a preponderance of the convincing evidence that the proposed development of water power is sound economically or attractive financially.[39]

Sanitation. On this question the New Jersey complaint alleged great and serious injury as resulting from the proposed diversion because:

> The undiminished and unobstructed flow of the Delaware River at all normal and flood stages, and of all of the tributaries thereof are necessary for the dilution of said pollution and for purging said river, . . . A diminution or obstruction of the flow . . . will prevent such dilution and purging and will inflict great and irreparable injury . . .

destroy . . . the property and prosperity of the plaintiff . . . and prejudice and menace the health of its inhabitants.[40]

Much detailed and highly technical testimony was presented on this phase of the case. New Jersey sought to prove, among other things, that the use of the watershed areas in New York for summer vacationing purposes was exceedingly detrimental to her interests, while the same use of land within her own borders was highly desirable and would be injured by the New York plan. This contradiction did not clarify the situation and produced an effect similar to that referred to under the previous heading.

Most of the testimony on this branch of the case centered around the proposition that, if any water were removed from the river, the concentration of the pollution would be increased, and great weight was attached to the effect of the sewage of the 18 000 people of Port Jervis, the only measurable source of pollution in New York. At practically all stages of this branch of the case, it was evident that if this particular pollution were removed the entire issue would be composed. The Special Master therefore wisely requested that the experts of all three parties advise him as to the range in the per capita cost of purifying sewage in cities of various sizes.

On the final argument before the Special Master, the city of New York stated that no objection would be entered to a finding requiring this sewage to be treated, and the Special Master reported, as already herein noted, that before any diversion is made a treatment works for this purpose shall be installed.

The finding of the Special Master on the general question of sanitation was as follows:

> On the whole, I am of the opinion and so find that the operation of the New York plan will impair to some extent, though not greatly, the sanitary condition of the Delaware River. I am further of the opinion, however, and so find, that this impairment can be eliminated by requiring sewage treatment at Port Jervis and by changing the amount of water taken by New York City and by changing the plan of release of water, as will hereinafter be set forth.[41]

Municipal Water Supply. On this point, New Jersey contended that the New York plan would seriously affect the water supplies taken from the Delaware River by her cities and towns. In substance, this was a branch of the major question as to the effect of the plan on the sanitary quality of the Delaware water. The finding of the Special Master was as follows:

> The Delaware River is the source of water supply of Trenton, New Jersey and other New Jersey municipalities. The New York diversion will not materially affect the Delaware as a source of municipal water supply. The effect will be slight and immaterial.[42]

Industrial Use of Water. Much testimony as to the effect of the plan on industrial uses of the Delaware water was spread upon the record. In general, this testimony revolved around the proposition that any reduction

in the flow of the Delaware would, because of the softer quality of the water taken, result in a concentration of the soluble salts which enter the river below the state of New York.

New Jersey held that any such concentration would render the water unfit for use in boilers and for industrial purposes generally, unless it were treated and softened at great cost and expense. It was also contended that such phenols as might be in the water would be rendered more troublesome.

It appeared, of course, that nearly all of the boiler water now used from the Delaware is treated, and it was not shown that below Trenton there was any substantial direct use of river water for any industrial purpose; all such coming through the various municipal systems, excepting of course water employed for condenser purposes. In the argument, the attempt was made to confuse this latter use with that for boiler purposes and have it appear that the cost of treating boiler water should also be applied to condenser water. The argument thus indicated that the cost of treating condenser water would be $637 069.00 per year, and it was intimated that this was a measure of the damage that New Jersey would suffer.

So obvious an exaggeration was, of course, without effect, the facts of the situation being, that at Riegelsville, New Jersey, the hardness and the flow show the following general relationship:

Flow in c.f.s.	*Hardness in p.p.m.*
40 000	21
10 000	47
2 000	100

Great variations, however, occur at various times. Thus at 20 000 c.f.s., the range in hardness is from 28 to 48; at 10 000 c.f.s., from 33 to 56, while at 2 000 c.f.s., the observations showed a variation of from 71 to 100. Under these conditions, it was naturally impossible to prove that the plan of New York with its provisions for increasing the flow during low stages would sensibly or measurably operate to increase the hardness. The Special Master therefore had no difficulty in finding that:

> The effect of the New York diversion on the waters of the Delaware River for industrial uses will be slight and immaterial.[43]

Agriculture. Under this general heading, New Jersey alleged that:

> . . . adjoining the easterly bank of Delaware River . . . there are extensive areas of rich alluvial bottom lands . . . underneath which there is a permanent supply of ground water . . . maintained and the water in part supplied by the waters of Delaware River. The diversion proposed . . . will lower the level of ground water . . . to the detriment of these lands . . . and also as to lands at some distance therefrom . . . . As a result . . . the productivity and value of lands in the state of New Jersey, aggregating not less than 5 000 acres in extent, will be wholly or in part diminished or destroyed.[44]

To substantiate this allegation, there was much testimony of experts in both agriculture and engineering, but all of it was without avail when, on cross-examination, it was shown by one of the New Jersey witnesses that the land in question had its main value, not for farming, but for summer vacationing purposes. The field inspection showed the irrelevancy of this claim, much of it being for land that never has been nor ever can be cultivated. The Commonwealth of Pennsylvania, having many times as much good agricultural land along its part of the river and immediately opposite that of New Jersey, made no claim of damage or injury, and so the Special Master found:

> The effect of the New York diversion on agriculture and the cultivation of New Jersey lands bordering on the Delaware River will be slight and immaterial.[45]

Fish. On this subject, New Jersey alleged that the inhabitants of that state have enjoyed fishing in the Delaware since 1678; that large sums of money have been expended for the propagation of shad and other fish and that:

> The diversion of the waters proposed by said city will . . . seriously affect, if not destroy the fishing industry of the plaintiff and its citizens. . . .[46]

To substantiate these allegations, there was much testimony of practical fishermen based on the theory that if the flood flows should be reduced the shad would forsake the Delaware; it being the flood waters which act as the attracting magnet. This theory, from the biological point of view is of more than passing interest, because it might just as reasonably be inferred that the floods themselves are the direct cause of the spawning.

The presentation of this subject was merely a makeweight, and it was readily shown that there was no relationship whatever between floods and number of fish coming into the river. On the other hand, the size of the yearly catch declined from 4 000 000 in 1900 to 40 000 in 1927,—the obvious and inevitable effect of pollution by sewage and trade wastes. The Special Master found:

> The effect of the New York diversion on shad fisheries and the shad industry will be slight and immaterial.[47]

The Teredo. New Jersey brought evidence to show that the plan of New York would, by increasing the salinity in Delaware Bay, extend the area within which the teredo could operate to destroy docks and other structures. In the first place there are not now, nor is it likely that there will ever be, any such structures within the zone where, by the widest stretch of the imagination, the salinity could be sufficiently affected. The Special Master reported:

> I find that the effect of the operation of the New York plan, particularly as modified herein, will so slightly affect the salinities and areas in which the teredo can operate that any damage resulting from this source will be inconsequential.[48]

Recreation. The New Jersey complaint alleged that:

> The Delaware River . . . is renowned in art and literature for its scenic beauty and possesses valuable recreational advantages. . . . In this valley . . . are located many large hotels, boarding houses, camps and country clubs, to which thousands of the citizens of the plaintiff and other states resort . . . to enjoy the benefit of the scenery . . . and other forms of recreation and pleasure. In these enterprises and facilities the citizens of the plaintiff and other states have invested millions of dollars and their prosperity and usefulness depend upon an adequate supply of water in the Delaware River during the summer months.[49]

Twenty-three lay and two expert witnesses testified for New Jersey on this branch of the case. The lay witnesses naturally were unable to infer just what the effect of the New York plan would be, and fourteen of them were residents of Pennsylvania which Commonwealth offered no objection nor claimed injury on account of any effect of the New York plan on the recreational possibilities. In fact about 80 per cent. of all the recreational developments along the Delaware are located in Pennsylvania.

The New York diversion, both as originally proposed and as modified by the Special Master, could not, as an engineering matter, have caused any measurable change in the recreational conditions along the river. In fact, the majority of the experts who testified on this subject were of the opinion that the plan, in its original form, could produce no effect on the river which would be noticeable by any person along its shores and that the release of water during the drier years would be of substantial benefit to recreation, as for instance during the dry year of 1930 when, during the months of July, August and September, the flow would have been increased during 75 days and decreased only on 17 days, when the flows were several times the minimum. The average decrease on the 17 days would have been 89 c.f.s., while the average increase during the 75 days would have been 112 c.f.s., a marked betterment of conditions.

The finding of the Special Master in regard to recreation was as follows:

> The effect of the New York diversion on the recreational uses of the river will be to cause somewhat more than slight damage, particularly as affecting the reputation of the river as a place of recreational resort. The investment in recreational camps, hotels and other facilities is large.[50]

The only testimony relating to the "reputation" of the river was presented by a real estate agent who had made an appraisal of the value of the recreational lands along the Delaware in New Jersey. The record of his testimony on page 3229 is as follows:

> *Question.* Is there any other element that enters into real estate matters of that kind besides the actual conditions?
>
> *Answer.* Well, it is the reputation that a river resort gets, and one case of typhoid has been known to close up a camp, a camp in Pennsylvania, for the whole season. If the river is known to be polluted at a certain point, that ends the people coming there. It spreads, and if the Delaware River should unfortunately get that reputation, in my opinion, the people living along the river would let their property go begging — that is, for the present purpose.

This opinion of the witness was clearly predicated on typhoid fever and on pollution of the river rather than on the direct effect of the New York plan on recreation. It was, moreover, entirely suppositious in character and therefore not a reliable guide. As a practical matter, the natural conditions along the Delaware River are such that recreation is adversely affected both when there is too little water and when there is too much. The effect of the New York plan would therefore always be to improve matters under both of these conditions, while occasionally, in the middle zone, when conditions with respect to quantity of flow are at the best, the plan might cause either a small increase or a small decrease in the river's flow. The balance, however, would be on the side of improvement, especially during the long dry periods when improvement is most needed. The wide-awake boarding-house or resort operator will, therefore, hereafter advertise that his patrons need never again look forward to a minimum river because the city of New York has guaranteed to maintain the low flows at a point which will always be higher than that which the river has reached many times in the past. Thus will the reputation of the Delaware for recreational purposes be established and made better than it has ever been or could possibly be in the absence of a plan similar to that of New York.

Oysters. The most important and most appealing allegation of New Jersey was that relating to possible damage and injury to the oyster industry in Delaware Bay. The allegations as to this claim were as follows:

> The food of the oysters comes primarily from the fresh water. Its enemies, consisting of drills, drum fish, star fish and black mussels, all come from the sea and menace the oyster beds only when the supply of fresh water is reduced and the salinity increases. The oyster industry . . . could not exist except for the supply of fresh water which comes down the Delaware River, the flood waters of which are essential to drive out of the bay the high salinity and the oyster enemies which invade the oyster beds only during low fresh water periods. The plaintiff's oyster beds . . . constitute a source of great potential wealth . . . and is the only natural resource . . . which has increased under exploitation by man. . . . The proposed diversion . . . would extend the present period of one month of dry weather flow . . . to a period of approximately five months duration . . . when the oysters are most susceptible to adverse influences, and when their destructive enemies are most active and effective. . . . The oysters produced annually . . . have a food value equivalent to that of 150 000 dressed steers. . . . The diversion of water proposed . . . will substantially change the degree of salinity . . . in Delaware Bay and ultimately destroy the oyster industry . . .[51]

It is not possible within the limits of this paper to discuss this oyster question in all of its variations, and a brief summary must suffice.

On the very first averment of the complaint, it is of more than passing interest to observe that when the young oysters are moved to the planting grounds, they are always moved toward the ocean and, therefore, away from the fresher water. The oyster always grows better in more saline water, and it is, therefore, far from proved that his food comes principally from

the fresh water. Actually, the amount of food that any oyster can get is but a fraction of the amount that comes to him, and this, in turn, is dependent on his location with respect to the water currents. In absolutely slack water, an oyster might starve unless the food moved itself toward him.

During the trial of the case, the enemies of the oyster were exhibited and described in great detail. The drill is apparently the most dangerous, but an oyster of reasonable size, because of its shell thickness, is immune from his attack. Oysters, therefore, are not moved into saltier waters until their shells have shown sufficient growth. The drills apparently are, to some extent, influenced by the saltness of the water, that is to say, there is, for them, a "salinity death point" and, because they have no power of locomotion, the coming of a flood of fresh water may reduce the salinity sufficiently to exterminate them. By the same token, however, the lack of ability to move about should prevent other drills from again finding their way upstream after their predecessors have succumbed to a fresh-water flood. These were some of the theories both *pro* and *con* which were presented *in extenso* as to these oyster enemies. There seems to be no doubt as to the presence of the drill and its activity, but its spreading around on the oyster bottoms seems clearly to be the result of the operations of the oystermen who, as they dredge and sail about, are continually casting back the culls and thus in effect sowing broadcast the seeds of the oysters' destruction.

Much testimony was also adduced as to a great stationary pool of water of low salinity alleged to lie in the ocean outside the Delaware Capes and from which the tidal waters entering the bay are derived. By means of this pool, it was sought to show that the effect of the proposed diversion would be twofold: first, a reduction of the fresh-water flow would directly cause an increase of salinity within the bay, and, second, the tidal water entering the bay from the ocean pool would also be rendered more salty and would thus still further aggravate the conditions. This argument had both its attractions and its drawbacks, as anyone familiar with physical things can readily see.

Another theory advanced was that the young oyster, for its welfare, needs to find copper in the water; that all such copper came from the waters proposed to be diverted and that consequently great damage would result. No proof was offered that there was copper either in the water of the Catskill Mountains or in that of the ocean. Neither was any showing made as to whether copper finds its way into the rivers from the works of Man; nor indeed as to how much copper the oyster actually needs or in what form it would be best for his preferred welfare.

From the presentation of the case on oysters, it might well have been inferred that no oyster ever died except as the result of attack by an enemy and that enemies were always controlled absolutely by the salinity. It was interesting therefore to have one of New Jersey's own witnesses, who had qualified both as a biological expert and a practical oysterman, admit

that the oyster crop in Delaware Bay was one bushel of oysters per bushel of seed whereas, in Peconic Bay, where the water is much more saline, the yield is four bushels for one. This testimony shed much light on the entire problem and clearly confirmed, what has long been suspected, that the low yields in Delaware Bay are the direct result of too much fresh water. Any cause that would remedy this condition should therefore be welcomed by New Jersey.

The starfish, an enemy of the oyster, which operates by sucking the oyster out of his shell, also was discussed at length, and it was testified for New Jersey that this enemy was unknown in Delaware Bay before the spring of 1929. Now the starfish can move from place to place and thus follow that salinity environment which most pleases him wherever it is to be found. The year 1928 showed the wettest spring of record, and the stream flow in the spring of 1929 was well above the average, while both years as a whole were very wet, yet the starfish, for the first time in history, came on to the oyster beds in 1929, — notwithstanding the fact that, since stream-flow records were begun, there were 13 years drier than 1929 none of which had been preceded by a year as wet as 1928. Literally interpreted, this proof meant that the starfish has a strong preference for fresh water. It was a strange coincidence that the complaint of New Jersey should have been in preparation in the very same month that the starfish first came into the Delaware oyster regions.

The great ocean pool on which the witnesses of New Jersey predicated their conclusions as to a "salinity grade line" and other assumptions as to salinity conditions was described by one of them as having a length of 80 miles, a width of from 30 to 50 miles, with depths from 100 to 500 or 600 feet. But the existence of this pool was never clearly demonstrated, all the direct evidence being to the effect that the ocean nowhere presents so singular a condition of stagnation.

One of the witnesses for New Jersey testified that the salinity of the water near the center of the oyster grounds would, in the early part of the fall of 1929, have been increased by 1.5 parts per thousand by the operation of the New York plan while at the same point and at the same season the actual observed differences from year to year were as follows:

1927 was higher than 1928 by 4.1 points
1929 was higher than 1928 by 7.6 points
1929 was higher than 1927 by 3.5 points
1930 was higher than 1928 by 9.4 points
1930 was higher than 1929 by 1.8 points

On the basis of New Jersey's own testimony then, and with the New York plan in operation, the salinity in 1929 would have been no higher than it actually was under natural conditions in 1930 and, with the reserve flows released under the city's plan, the conditions in all years would have been even better. Were the oysters damaged by this large and wholly natural

increase of salinity in 1930? We think not, and so did the arguments of New Jersey contradict themselves. On the subject of oysters the Special Master reported:

> I am not persuaded that the New York diversion will have the great damaging effect on the oyster industry as charged in the bill of complaint. The outstanding fact in my mind is that the oyster is now living and thriving in Delaware Bay in salinities and conditions of wide variation, that it has adjusted itself to these varying salinities and conditions and that the execution of the New York plan does not make a relatively great change in salinities and other conditions.
>
> It is to be remembered, however, that the water diverted by New York never returns to Delaware River and Bay and that the diversion will at times increase and accentuate natural adverse variations in salinities and other conditions, except at those periods of very low flow when water is released from the impounding reservoirs. The evidence of practical oystermen as to larger crops in wet years than in dry years should also not be overlooked. In the conflict of evidence as to the effect on oysters, I reach the conclusion and so find that while the New York diversion will not have the very great damaging effect claimed by New Jersey, yet undoubtedly it will have the effect of producing more than slight damage and there will result a greater damaging effect than New Jersey should be called upon to bear under the principle of fair and equitable apportionment of the waters of the Delaware.
>
> I am further of the opinion and so find that by reducing the New York diversion and by modifying the plan of releasing water at low stages of the river, the damage to New Jersey will be so decreased that it will be slight and inconsequential.[52]

The Special Master here refers to the "conflict of evidence" between the experts and seems to have placed at least some reliance on the testimony of the practical oysterman. In this connection, it is to be observed that there is one important feature which was not brought out in the evidence, namely, that the quality of the oyster crop in any year is much more dependent on the growing conditions during at least three seasons prior to the year of its harvesting than it is on the stream flow of that particular year. It is most likely, therefore, that the excellent crop of 1928 was not nearly so much the result of the wet spring of that year as it was of the much drier years of 1924, 1925 and 1926 when this particular crop was laying the foundations of its future greatness. The oyster is neither an annual nor a perennial. Its life cycle extends over a number of years, and, as in the case of the human infant, the environment of its early days is far more potent in directing its development than is any later condition of surroundings.

Conflict of Evidence.

In a proceeding of such wide scope as that in this Delaware River case, it was inevitable that there should be conflict, inconsistency and even contradiction in the testimony of witnesses. This has long been recognized as an unfortunate condition and one which can be remedied and avoided only by the Engineer himself. The present tendency is for him to appear as a special advocate in the case, whereas his effort should always be to seek only to clarify the technical features of the case so as to present them

lucidly to the view and the understanding of the Court. Instead of simplification, the tendency is also toward complication by means of theories, curves, diagrams and symbols, all of which, while more readily understandable by the technical man, add little more than confusion to the tasks of Judges. The Special Master in this case, as others before him in similar cases, could only reconcile and resolve these artificial conflicts by a general weighing of the evidence and by seeking for those simple facts which would develop the truth of each particular situation. On this subject he reported:

> I should also refer to another principle of law which I have applied in this case. This has reference to determining conflicts of evidence, particularly conflicts of evidence between experts of high standing, on the effect of the proposed New York diversion. The principle to which I refer is thus stated in *North Dakota* v. *Minnesota*, 263 U. S. 385:
>
> "It is difficult for a court to decide issues of fact upon which experts equal in number and standing differ flatly, and when their conclusions rest on estimates upon the correctness of which the court, without technical knowledge, cannot undertake to pass. *In such cases, the court looks about for outstanding facts from which the lay mind can safely draw inferences as to the probabilities.* The court is also aided by its judgment of the care and accuracy with which the contrasted experts respectively have determined the data upon which they base their conclusions."[53]

The "outstanding facts," expressed in plain and simple language, are always most potent and convincing. No complicated and abstruse presentation can ever prevail against them. The difficulty of the situation is that when one side in a case makes such a presentation the other is often tempted to retaliate in kind, and thus the confusion is made the worse. The remedy lies both in the "outstanding fact" as well as in the designation by the Court of an engineer to sit with the Master on all important cases and advise him as to the value of all technical testimony. The presence of such an authority would simplify the task of the Master and, at the same time, much irrelevant matter would be kept out of the record.

The Decision of the Supreme Court.

The decision in the Delaware River case was written by Mr. Justice Holmes in his usual concise and vigorous manner. It presents practically every main feature of the controversy and, because of its great value to all those who are interested in the question of interstate water rights, it is presented in full as an appendix to this paper.

The words and phraseology of this decision are so characteristic of the great Justice who wrote them that it is impossible to refrain from quoting:

> A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it. New York has the physical power to cut off all the water within its jurisdiction. But clearly the exercise of such power could not be tolerated. And on the other hand equally little could New Jersey be permitted to require New York to give up its power altogether in order that the river might come down to it undiminished.

These words of Mr. Justice Holmes will go down into history and literature. Clearly and concisely do they present the situation with regard to every interstate river. Recognizing the sovereign power of the upper state, exactly as the power of the state "in possession" was recognized by Mr. Justice Baldwin in 1838, the limitations on this power and the reciprocal obligations of the lower state are clearly emphasized. *The power to do is always qualified by the right to do, while the right to prohibit is always limited by a lack of power.* Thus has Providence decreed and so, inevitably, are the rights and powers of every state qualified by its obligations.

Mr. Justice Holmes also wrote:

> In a most competent and excellent report the Master adopted the principle of equitable division which clearly results from the decisions of the last quarter of a century. Where that principle is established there is not much left to discuss. The removal of water to a different watershed obviously must be allowed at times unless states are to be deprived of the most beneficial use on formal grounds. In fact it has been allowed repeatedly and has been practiced by the states concerned.

So was the principle of equitable division upheld, and so was the ancient riparian doctrine with respect to a diversion from one watershed to another shown to be inapplicable to the case of interstate waters. The absolute and abstract character of that doctrine disqualifies it as a just and equitable principle of adjudication between sovereign states.

This decision, together with those in *Connecticut* v. *Massachusetts*[14] and *Arizona* v. *California et al*,[17] constitute the final word, as of 1931, on the Common Law, under the heading of interstate waters. The first of the several decisions which have made up the greater part of the body of this law was that in *Missouri* v. *Illinois*,[54] decided in 1906. That decision was also handed down by Mr. Justice Holmes who is, therefore, in the unique position of having actively participated in the formulation of practically every principle in this most important branch of the law.

The Decree.

Pursuant to the decision, the decree in this case was entered on May 25, 1931. This decree marks a new procedural step in the policy of the Supreme Court with respect to interstate waters, in that the Court retains a continuing jurisdiction of the subject matter and that:

> 6. Any of the parties hereto, complainant, defendants or intervenor, may apply at the foot of this decree for other or further action or relief and this Court retains jurisdiction of the suit for the purpose of any order or direction or modification of this decree, or any supplemental decree that it may deem at any time to be proper in relation to the subject matter in controversy.

The effect of this provision is to serve notice, in cases where there is a variety of interest in several states, that it is highly desirable to provide means for a prompt determination of differences that may arise or of new uses of water that may be contemplated. Thus, any one of the three states

may hereafter apply to the Court for its sanction of a plan to use water from the Delaware River or its tributaries, or for a modification of the method of low-flow release or for any other matter properly relating to the waters of that river.

Closure.

The outcome of this case seems to have been entirely satisfactory both to the State and City of New York and to the Commonwealth of Pennsylvania, even as it should be to the State of New Jersey. The final word of the Supreme Court has recognized her sovereign rights equally with those of the other states. All of the states are on the same plane of equality, and each must ever march in the ranks before which the shield of Justice goes.

Counsel for the parties in this case should be, at least, as satisfied as their respective clients. As officers of the Court they gave unsparingly of their time and of their energy to the end that both the facts and the law might be well and truly determined.

The Engineer, as the representative of the people, charged with the duty of determining the true facts and, out of his technical knowledge, making them clear to the Court, he too, is content in the result. On behalf of his Profession, he has participated in the firmer establishment of sound principles of interstate law. Without him, no fundamental doctrine relating to water could be declared in this scientific age. Yet, even in his satisfaction, the Engineer may well profit by experience and remember that his efforts before the courts are, at every step, subject to the relentless test of rationality and that his presentation of the facts must be such as to show no flaw when the microscope of reason is directed upon them.

Acknowledgments.

In the preparation of this paper, the author has had the efficient help of his assistants, Francis B. Marsh, a Member of this Association, and Donald G. Follett. He is also deeply grateful for the comments, emendments and helpful suggestions extended, during its preparation, by his good friends, Messrs. J. Joseph Lilly, Frank H. Deal and Thomas Penney, Jr., of the New York Bar.

REFERENCES.

[1] *Coggs* v. *Bernard*, 2 Ld. Raym. 911.

[2] Mr. Justice Brewer in *Kansas* v. *Colorado*, 206 U. S. 46, 96, wrote:

> "As it" (the Common Law) "does not rest on any statute or other written declaration of the sovereign, there must, as to each principle thereof, be a first statement. Those statements are found in the decisions of courts, and the first statement presents the principle as certainly as the last. Multiplication of declarations merely adds certainty. For after all, the common law is but the accumulated expressions of the various judicial tribunals in their efforts to ascertain what is right and just between individuals in respect to private disputes."

[3] *Hudson County Water Co.* v. *McCarter*, 209 U. S. 349, 355.

[4] 3 Kent. Com., 439.

[5] *Clark* v. *Allaman*, 71 Kan. 206; 80 Pac. 581.

[6] 3 Kent. Com., 439 — quoted under reference No. 4.

[7] *Elliott* v. *Fitchburg R. R. Co.*, 10 Cush. 191,196.

[8] *Hudson County Water Co.* v. *McCarter*, 209 U. S. 349, 356.

[9] *Basey* v. *Gallagher*, 20 Wall. 670, 682.

[10] *Wyoming* v. *Colorado*, 259 U. S. 419, 470.

[11] *Wyoming* v. *Colorado*, 259 U. S. 419, 466.

[12] *Hudson County Water Co.* v. *McCarter*, 209 U. S. 349, 356.

[13] *Kansas* v. *Colorado*, 185 U. S. 125 and 206 U. S. 46.

[14] *Connecticut* v. *Massachusetts*, 282 U. S. 660.

[15] *New Jersey* v. *New York and the City of New York*, 283 U. S. 336.

[16] *Rhode Island* v. *Massachusetts*, 12 Pet. 726.

[17] *Arizona* v. *California et al.*, 283 U. S. 423.

[18] *Georgia* v. *Tennessee Copper Co.*, 206 U. S. 230, 237.

[19] *Kansas* v. *Colorado*, 206 U. S. 46, 92.

[20] New Jersey Bill of Complaint, p. 27.

[21] Pennsylvania Statement of Interest, p. 3.

[22] Pennsylvania Statement of Interest, p. 4.

[23] Report of Special Master, p. 207.

[24] Report of Special Master, p. 207.

[25] Report of Special Master, p. 200.

[26] Report of Special Master, p. 201.

[27] New Jersey Bill of Complaint, p. 20.

[28] New Jersey Bill of Complaint, p. 21.

[29] New Jersey Bill of Complaint, p. 21.

[30] New Jersey Bill of Complaint, p. 23.

[31] Report of Special Master, p. 201.

[32] Report of Special Master, p. 202.

[33] Report of Special Master, p. 202.

[34] Report of Special Master, p. 202.

[35] Report of Special Master, p. 42.

[36] Report of Special Master, p. 45.

[37] Report of Special Master, p. 94.

[38] New Jersey Bill of Complaint, p. 19.

[39] Report of Special Master, pp. 204, 205.

[40] New Jersey Bill of Complaint, p. 15.

[41] Report of Special Master, p. 125.

[42] Report of Special Master, p. 205.

[43] Report of Special Master, p. 205.

[44] New Jersey Bill of Complaint, pp. 23, 24.

[45] Report of Special Master, p. 205.

[46] New Jersey Bill of Complaint, p. 18.

[47] Report of Special Master, p. 205.

[48] Report of Special Master, p. 177.

[49] New Jersey Bill of Complaint, pp. 18, 19.

[50] Report of Special Master, p. 205.

[51] New Jersey Bill of Complaint, pp. 16, 17.

[52] Report of Special Master, p. 176.

[53] Report of Special Master, p. 40.

[54] *Missouri* v. *Illinois*, 200 U. S. 496.

[55] *Williams* v. *Morland*, King's Bench, 1824 (Reported to B. & C. 910). In this case Bayley, J., wrote:

"I think that this rule ought to be discharged. My judgment in this case is founded on the nature of the flowing water, and the manner in which an exclusive right to it is obtained. Flowing water is originally *publici juris*. So soon as it is appropriated by an individual, his right is co-extensive with the beneficial use to which he appropriates it. Subject to that right all the rest of the water remains *publici juris*. The party who obtains a right to the exclusive enjoyment of the water does so in derogation of the primitive right of the public. Now if this be the true character of the right to water, a party complaining of the breach of such a right ought to show that he is prevented from having water which he has acquired a right to use for some beneficial purpose. Here the declaration states a right to the use of this water at all times; but still, if the plaintiff had as much water as could be necessary for his purposes, the defendant would have been guilty of no wrong, by preventing additional water from coming to the plaintiff's premises."

In this same case Holroyd, J., wrote:

"The mere obstruction of the water which had been used to flow through his land does not of itself give any right of action. In order to entitle himself to recover, he should show the loss of some benefit or the deterioration of the value of the premises."

Also Littledate, J., expressed the view, that:

"Water is of the peculiar nature, that it is not sufficient to allege in a declaration, that the defendant prevented the water from flowing to the plaintiff's premises. The plaintiff must state an actual damage accruing from the want of the water. The mere right to use the water does not give a party such a property in the new water constantly coming, as to make the diversion or obstructions of the water, *per se*, give him any right of action."

[56] *Embrey* v. *Owen*, Exchequer. 1851 (Reported 6 Ex. 353).

In this case the decision reads:

"It was very ably argued before us by the learned counsel for the plaintiffs, that the plaintiffs had a right to the full flow of the water in its natural course and abundance, as an incident to their property in the land through which it flowed; and that any abstraction of the water, however inconsiderable, by another riparian proprietor, and though productive of no actual damage, would be actionable because it was an injury to a right, and, if continued, would be the foundation of a claim to adverse right in that proprietor.

"This right to the benefit and advantage of the water flowing past his land, is not an absolute and exclusive right to the flow of all the water in its natural state; if it were, the argument of the learned counsel, that every abstraction of it would give a cause of action, would be irrefragable; but it is a right only to the flow of the water, and the enjoyment of it subject to the similar rights of all the proprietors of the banks on each side to the reasonable enjoyment of the same gift of Providence.

"The just and equitable principle is given in the Roman Law: *Sic enim debere quem meliorem agrum suum facere ne vicini deteriorem faciat.*"

APPENDIX.

SUPREME COURT OF THE UNITED STATES.

No. 16, Original. — OCTOBER TERM, 1930.

State of New Jersey, Plaintiff,
vs.
State of New York and City of New York, Defendants,
Commonwealth of Pennsylvania, Intervenor.

[May 4, 1931.]

Mr. Justice HOLMES delivered the opinion of the Court.

This is a bill in equity by which the State of New Jersey seeks to enjoin the State of New York and the City of New York from diverting any waters from the Delaware River or its tributaries, and particularly from the Neversink River, Willowemoc River, Beaver Kill, East Branch of the Delaware River and Little Delaware River, or from any part of any one of them. The other rivers named are among the headwaters of the Delaware and flow into it where it forms a boundary between New York and Pennsylvania. The Delaware continues its course as such boundary to Tristate Rock, near Port Jervis in New York, at which point Pennsylvania and New York are met by New Jersey. From there the river marks the boundary between Pennsylvania and New Jersey until Pennsylvania stops at the Delaware state line, and from then on the river divides Delaware from New Jersey until it reaches the Atlantic between Cape Henlopen and Cape May.

New York proposes to divert a large amount of water from the above-named tributaries of the Delaware and from the watershed of that river to the watershed of the Hudson River in order to increase the water supply of the City of New York. New Jersey insists on a strict application of the rules of the common law governing private riparian proprietors subject to the same sovereign power. Pennsylvania intervenes to protect its interests as against anything that might be done to prejudice its future needs.

We are met at the outset by the question what rule is to be applied. It is established that a more liberal answer may be given than in a controversy between neighbors members of a single State. *Connecticut* v. *Massachusetts*, February 24, 1931. Different considerations come in when we are dealing with independent sovereigns having to regard the welfare of the whole population and when the alternative to settlement is war. In a less degree, perhaps, the same is true of the quasi-sovereignties bound together in the Union. A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it. New York has the physical power to cut off all the water within its jurisdiction. But clearly the exercise of such a power to the destruction of the interest of lower States could not be tolerated. And on the other hand equally little could New Jersey be permitted to require New York to give up its power altogether in order that the river might come down to it undiminished. Both States have real and substantial interests in the River that must be reconciled as best they may be. The different traditions and practices in different parts of the country may lead to varying results but the effort always is to secure an equitable apportionment without quibbling over formulas. *See Missouri* v. *Illinois*, 200 U. S. 496, 520. *Kansas* v. *Colorado*, 206 U. S. 46, 98, 117. *Georgia* v. *Tennessee Copper Co.*, 206 U. S. 230, 237. *Wyoming* v. *Colorado*, 259 U. S. 419, 465, 470. *Connecticut* v. *Massachusetts*, February 24, 1931.

This case was referred to a Master and a great mass of evidence was taken. In a

most competent and excellent report the Master adopted the principle of equitable division which clearly results from the decisions of the last quarter of a century. Where that principle is established there is not much left to discuss. The removal of water to a different watershed obviously must be allowed at times unless States are to be deprived of the most beneficial use on formal grounds. In fact it has been allowed repeatedly and has been practiced by the States concerned. *Missouri* v. *Illinois*, 200 U. S. 496, 526. *Wyoming* v. *Colorado*, 259 U. S. 419, 466. *Connecticut* v. *Massachusetts*, February 24, 1931.

New Jersey alleges that the proposed diversion will transgress its rights in many respects. That it will interfere with the navigability of the Delaware without the authority of Congress or the Secretary of War. That it will deprive the State and its citizens who are riparian owners of the undiminished flow of the stream to which they are entitled by the common law as adopted by both States. That it will injuriously affect water power and the ability to develop it. That it will injuriously affect the sanitary conditions of the River. That it will do the same to the industrial use of it. That it will increase the salinity of the lower part of the River and of Delaware Bay to the injury of the oyster industry there. That it will injure the shad fisheries. That it will do the same to the municipal water supply of the New Jersey towns and cities on the River. That by lowering the level of the water it will injure the cultivation of adjoining lands; and finally, that it will injuriously affect the River for recreational purposes. The bill also complains of the change of watershed, already disposed of; denies the necessity of the diversion; charges extravagant use of present supplies, and alleges that the plan will violate the Federal Water Power Act, (but see U. S. Code, Tit. 16, § 821,) interfere with interstate commerce, prefer the ports of New York to those of New Jersey and will take the property of New Jersey and its citizens without due process of law.

The Master finds that the above-named tributaries of the Delaware are not navigable waters of the United States at and above the places where the City of New York proposes to erect dams. Assuming that relief by injunction still might be proper if a substantial diminution within the limits of navigability was threatened, *United States* v. *Rio Grande Dam & Irrigation Co.*, 174 U. S. 690, 709, he called as a witness General George B. Pillsbury, Assistant Chief of Engineers of the United States Army, who was well acquainted with the River and the plan, and who although not speaking officially for the War Department, satisfied the Master's mind that the navigable capacity of the River would not be impaired. Of course in that particular as in some others New York takes the risk of the future. If the War Department should in future change its present disinclination to interfere, New York would have to yield to its decision, and the possible experiences of the future may make modifications of the plan as it now stands necessary in unforeseen particulars. This will be provided for in the decree. Subject to these considerations and to what remains to be said the New York plan as qualified here is reasonably necessary. Some plan must be formed and soon acted upon, and taking into account the superior quality of the water and the other advantages of the proposed site over others it at least is not arbitrary or beyond the freedom of choice that must be left to New York.

With regard to water power the Master concludes that any future plan of New Jersey for constructing dams would need the consent of Congress and of the States of New York and Pennsylvania and though possible as a matter of engineering probably would not pay. He adds that there is no such showing of a present interest as to entitle New Jersey to relief. *New York* v. *Illinois*, 274 U. S. 488, 490. *New Jersey* v. *Sargent*, 269 U. S. 328. We have spoken at the outset of the more general qualifications of New Jersey's rights as against another State. The Master finds that the taking of 600 millions of gallons daily from the tributaries will not materially affect the River or its sanitary condition, or as a source of municipal water supply, or for industrial uses, or for agriculture, or for the fisheries for shad. The effect or the use for recreation and upon its reputation in that regard will be somewhat more serious as will be the effect of increased sal-

inity of the River upon the oyster fisheries. The total is found to be greater than New Jersey ought to bear, but the damage can be removed by reducing the draft of New York to 440 million gallons daily; constructing an efficient plant for the treatment of sewage entering the Delaware or Neversink (the main source of present pollution) thereby reducing the organic impurities 85 per cent., and treating the effluent with a germicide so as to reduce the Bacillus Coli originally present in the sewage by 90 per cent.; and finally, subject to the qualifications in the decree, when the stage of the Delaware falls below .50 c.s.m. at Port Jervis, New York, or Trenton, New Jersey, by releasing water from the impounding reservoirs of New York, sufficient to restore the flow at those points to .50 c.s.m. We are of opinion that the Master's report should be confirmed and that a decree should be entered to the following effect, subject to such modifications as may be ordered by the Court hereafter.

1. The injunction prayed for by New Jersey so far as it would restrain the State of New York or City of New York from diverting from the Delaware River or its tributaries to the New York City water supply the equivalent of 440 million gallons of water daily is denied, but is granted to restrain the said State and City from diverting water in excess of that amount. The denial of the injunction as above is subject to the following conditions.

(a) Before any diversion shall be made an efficient plant for the treatment of sewage at Port Jervis, New York, shall be constructed and the sewage of Port Jervis entering the Delaware or Neversink Rivers shall be treated to such an extent as to effect a reduction of 85 per cent. in the organic impurities. And the effluent from such plant shall be treated with a chemical germicide, or otherwise, so that the B. coli originally present in the sewage shall be reduced by 90 per cent.

Untreated industrial waste from plants in said town of Port Jervis shall not be allowed to enter the Delaware or Neversink Rivers, and the treatment of such industrial wastes shall be such as to render the effluent practically free from suspended matter and non-putrescent; and said treatment of sewage and industrial waste shall be maintained so long as any diversion is made from the Delaware River or its tributaries.

(b) At any time the stage of the Delaware River falls below .50 c.s.m. at Port Jervis, New York, or Trenton, New Jersey, or both (.50 c.s.m. being equivalent to a flow of 1 535 c.f.s. at Port Jervis and 3 400 c.f.s. at Trenton), water shall be released from one or more of the impounding reservoirs of New York City in sufficient volume to restore the flow at Port Jervis and Trenton to .50 c.s.m., provided, however, that there is not required to be released at any time water in excess of 30 per cent. of the diversion area yield, and the diversion area yield having been ascertained to be 2.2 c.s.m., the maximum release required shall be 30 per cent. of that amount, or .66 c.f.s. per sq. mile of the areas from which water is diverted.

In determining the quantity of water to be released so as to add to the flow of the Delaware River, the Neversink River shall be treated as if it flowed into the Delaware River above Port Jervis, and the number of second feet of water released from the impounding reservoir on the Neversink River shall be added to the number of second feet of water released from other reservoirs, so as to determine whether the quantity of water, required by this decree to be released, has been released.

(c) That the State of New Jersey and the Commonwealth of Pennsylvania, through accredited representatives, shall at all reasonable times have the right to inspect the dams, reservoirs and other works constructed by the City of New York and to inspect the diversion areas and the inflow, outflow and diverted flow of said areas, and to inspect the meters and other apparatus installed by the City of New York and to inspect all records pertaining to inflow, outflow and diverted flow.

2. The diversion herein allowed shall not constitute a prior appropriation and shall not give the State of New York and City of New York any superiority of right over the State of New Jersey and Commonwealth of Pennsylvania in the enjoyment and use of the Delaware River and its tributaries.

3. The prayer of the intervenor, Commonwealth of Pennsylvania, for the present allocation to it of the equivalent of 750 million gallons of water daily from the Delaware River or its Pennsylvania tributaries is denied without prejudice.

4. The prayer of the Commonwealth of Pennsylvania for the appointment of a river master is denied without prejudice.

5. This decree is without prejudice to the United States and particularly is subject to the paramount authority of Congress in respect to navigation and navigable waters of the United States, and subject to the powers of the Secretary of War and Chief of Engineers of the United States Army in respect to navigation and navigable waters of the United States.

6. Any of the parties hereto, complainant, defendants or intervenor, may apply at the foot of this decree for other or further action or relief and this Court retains jurisdiction of the suit for the purpose of any order or direction or modification of this decree, or any supplemental decree that it may deem at any time to be proper in relation to the subject matter in controversy.

7. The costs of the cause shall be divided and shall be paid by the parties in the following proportions: State of New Jersey 35 per cent., City of New York 35 per cent., State of New York 15 per cent., Commonwealth of Pennsylvania 15 per cent.

The CHIEF Justice and Mr. Justice ROBERTS took no part in the consideration or decision of this case.

A true copy.

Test: CHARLES ELMORE CROPLEY,
Clerk, Supreme Court, U. S.

DISCUSSION.

Discussion by Morris R. Sherrerd.*

The author's admirable presentation and analysis of the result of the Delaware River diversion case, as conducted before the Supreme Court of the United States, deserve the thanks of the engineering profession; particularly of those of us who are more especially interested in water supply. The comprehensive presentation of the gradual steps by which the court decisions have given a certain elasticity to the early common-law rulings as to the rights of riparian owners in running waters is a classic. The result of this and the Connecticut River case are clearly a confirmation of the prophecy of the author and of his conferee, Mr. J. Waldo Smith, now Consulting Engineer of the Board of Water Supply, and, incidentally, it might be mentioned, also a confirmation of the viewpoint of Mr. Frank H. Sommer, Dean of the New York University Law School, in his advice to the New Jersey Commissioners who negotiated the second proposed compact between the states of New York, New Jersey and Pennsylvania, for the utilization of the waters of the Delaware River.

The writer had the honor to be associated with the work of the New Jersey commission in the preparation of the second suggested compact, and was never in accord with the legal position taken by representatives of New Jersey in the Delaware River suit. This suit and its results have, however, cleared the atmosphere and will, no doubt, be helpful in eliminating those conscientious objectors in New Jersey who were inclined to stand on the narrow interpretation of riparian rights, which would, if sustained, keep New York from the diversion of the waters of the Upper Delaware. Now that this point has been settled by the Supreme Court — that the river can be utilized, under reasonable restrictions, for the benefit of all three states — perhaps the working out of these reasonable restrictions should still be a matter of treaty negotiations; but with or without further treaty negotiations, under the Supreme Court decision, the use of the waters of the Delaware for water supply purposes (its highest use) can be brought about to the mutual advantage of all three states.

The writer is inclined to take exception to the interjection into this highest use of the waters of the Delaware River for potable water purposes the placing, on the water supply developers of the cost of sewage treatment, which has always seemed to him to be an unfair burden on water supply developments. The use of streams for the disposal of sewage without treatment is an obvious tort against riparian owners below the point of discharge of such sewage. The whole controversy over the use of the Delaware River water for potable water supply purposes was clouded by the interjection of, or the attempt to interject, the burden for the removal of sewage pollution into the subject. New Jersey had taken more drastic steps to cause the

*Chief Engineer, New Jersey State Water Policy Commission, Trenton, N. J.

municipalities in that state bordering on the Delaware River from discharging untreated sewage into the river than had been taken by Pennsylvania, and, in the writer's opinion, a suit by New Jersey to prevent Pennsylvania from defiling the waters of the Delaware should have taken precedence and have been brought to a settlement before New Jersey should have raised the question it did on the diversion of the waters of the Upper Delaware, which were proposed to be taken only in accordance with the terms of the compact unanimously agreed upon by the commissions of the three states.

Perhaps the decision now rendered by the Supreme Court, which places a burden on New York diverters to install sewage treatment works at Port Jervis, may also be applied to drastic regulations for the removal of sewage pollution from the river below Port Jervis. If so, perhaps two suits were settled in one: That of the utilization of the Delaware for water supply purposes, and the proposed suit directed to be brought by the Legislature of New Jersey to prevent Pennsylvania from the discharge of sewage pollution into the Delaware River.

During the period of the controversy over the proposed treaty, the city of Trenton was the main objector in New Jersey and, while admitting that the low flow of the river which was established by the proposed treaty was adequate for all its needs as regards quantity of water available for water supply purposes, the question was raised as to the ultimate carrying out of the treaty being detrimental to the city of Trenton's interest, because it would continue the low flow at Trenton for a longer period of time and the river, to that extent, would be less of a diluting medium for the sewage pollution which reaches it in very much greater degree from the Pennsylvania tributaries of the Delaware than from any other portion of the drainage area above Trenton. Certainly, in the interest of the protection of the river, not only for water supply purposes, but for general scenic and pleasure purposes, the pollution which now finds its way to the river ought to be eliminated.

With the general conclusion of the author of the paper that progress has been made in the control and use of interstate waters, under reasonable restrictions, the writer concurs, but he still believes that there is room for improvement by treaty negotiations, taking as a basis therefor the second compact proposed by the representatives of all the three states primarily interested in the utilization of the waters of the Delaware River.

Discussion by Howard T. Critchlow.*

The paper under discussion is one of two on the general subject of "The Allocation of Interstate Waters for Water Supply Purposes."

The allocation of interstate waters involves their diversion and use

*Division Engineer, New Jersey State Water Policy Commission, Trenton, N. J.

in such a way, by one state or a subdivision thereof, so as to deprive another state of their use.

Why did the United States Supreme Court decide the Delaware case in the way it did?

In answering this question it must be assumed that it applied the mandate of existing laws and/or interpreted existing laws in the light of public necessity and public opinion.

Prior to the decisions in the Connecticut and Delaware River cases, it was generally assumed that either the riparian doctrine or the doctrine of appropriation governed, depending on the locality in question. Now we have, for the first time, a clean-cut decision based upon the principle of equitable diversion of interstate waters. This principle implies the diversion and use of the waters in such a way as to leave the state deprived of the use substantially uninjured; in the Delaware case, this principle also implies no prior appropriation to one state as against another.

While the decision denied the injunction against the diversion to New York City, the Court only permitted a partial diversion upon certain conditions which were obviously designed to minimize the damage that would otherwise have been suffered along the lower river. The conditions were also designed to apply the principle of "compensation in kind." The formula of reserved flow is not fixed, but it is in the nature of an experiment and subject to modification by the Court.

When the writer reads the Special Master's report in the light of the decision that followed, he cannot help but feel that the Master believed a modification of the formula of reserved flow would be upward rather than downward. However, only the future will see what will be done.

Decisions of the Supreme Court are fundamental rather than specific. Therefore, the interesting thing now is to speculate how the decision will control and affect the other states when they come to divert and use their share of the Delaware River, for obviously they have a share and undoubtedly will need to utilize it at some future time.

The writer believes the logical outcome will be, or at least should be, the adoption of interstate compacts which will enable interstate streams to be used as public necessity demands and thus forestall litigation and delay. In that way, the engineers and the public officials, whose duty it is to supply water, can plan comprehensively and prudently to meet future needs for a vital necessity in the progress of mankind.

The writer congratulates the author on the thorough and comprehensive manner in which he has presented his paper on this extremely interesting and important subject. His breadth of vision not only reviews the case of the Delaware River both technically and legally down to the present time, but also looks to the future development of this and other interstate streams which must of necessity be utilized to meet the future needs of various parts of the country.

As Mr. Justice Holmes writes: "Both states have real and substantial

interests in the river that must be reconciled as best they may be." As the author states: "There resides in every state a basic right to use a substantial part of the water which comes into being upon its own soil and flows thence into an interstate stream . . . it being provided, however, that no upper state can go beyond a reasonable use"; and the writer would add: "nor inflict material damage on its neighbor's."

The author, it seems to the writer, is inclined to take New Jersey to task for instituting suit against New York. As a matter of fact, New Jersey was faced with the alternative of bringing suit or of permitting the plan of New York City to proceed unopposed. In the latter event there would be no control over the manner of development and use, and in the course of time, and on its own initiative, New York City would then be able to make additional developments in the Delaware watersheds to meet its needs. To have adopted this procedure would not have protected the interests of New Jersey in its largest undeveloped water resource. New York City, in order to meet the needs for additional water, after considerable study of the problem, decided to go to the Delaware River for additional supply. It made an honest effort to have the states of New York, New Jersey and Pennsylvania negotiate a compact for the allocation of the waters of the Delaware. The final result, however, was that neither of the two compacts that were negotiated was ratified by the legislatures of all the states. The city then proceeded to adopt and carry out a plan which would have been permitted under the proposed compact of 1927. New Jersey instituted suit, the complaint being based largely upon riparian doctrine. One of the particulars in the bill stated that the plan of New York, if permitted, would impose upon New Jersey a system of diversion and appropriation of the Delaware waters, and that no such system could be made effective except through an interstate compact. In short, New Jersey contended that New York could not carry out the plan without some agreement with New Jersey.

The result of the case has been that the Court has allotted a portion of the waters of the Delaware to New York under conditions which are designed to minimize the injury that might otherwise be suffered. As has been pointed out in detail by the author, the plan of New York was modified by reducing the amount of water to be taken, modifying the plan of release in order to improve the conditions of the lower river in periods of low flow, and by requiring the treatment of sewage and industrial wastes at Port Jervis.

The Special Master in his report gives reasons for recommending these modifications. They are, in brief: to minimize the damage to recreation, to the sanitary condition of the river and to the oyster industry.

As the writer registers the reaction to the decision in this case, the state of New Jersey is satisfied with the outcome, from the political, technical, and legal standpoints.

The author records that "The outcome of this case seems to have been

entirely satisfactory both to the State and City of New York, and to the Commonwealth of Pennsylvania. . . . ."

It, therefore, seems to the writer, in view of the mutual satisfaction in all of the states, that the way is now open, as perhaps never before, for the negotiation of a compact which will form the basis of the future development of the Delaware River for the benefit of the peoples of the three states. If this can be accomplished, the writer for one believes that the honest differences in the past can be composed and a satisfactory agreement reached.

DISCUSSION BY H. K. BARROWS.*

The conditions under which interstate diversion of water may take place have now been fairly clearly established. The approximate limit in taking has apparently also been fixed in the Delaware case. New Jersey sought to restrain New York City from taking any water. That injunction was denied. But New York was limited to the taking of 440 m.g.d. The Master found, in respect to the damage to the oyster industry, that any taking in excess of this amount would impose "a greater damaging effect than New Jersey should be called upon to bear," thus fixing a limit.

Practically the same situation prevailed with reference to recreation, another important aspect of the case.

In the matter of water power something further should be said. The obstacle at the present time to development of water power on the Delaware River is, as some of the other matters referred to in the case, very largely political. There is an agreement between the states of New Jersey and Pennsylvania which prohibits the construction of dams across the Delaware River, ratified many years ago from the point of view of protecting navigation. It is now a complete dead letter, but at the same time it serves as a rather serious obstacle toward power development.

The whole Delaware River has available a total of over 350 000 h.p. of primary power, — a splendid block of power, made up of some very good projects and some poorer ones. It was intended in presenting information on these various projects to show what could be done with the whole river. The Master took the point of view that as no plants had been built, there was no basis for an injunction from the point of view of damage to water power. Plants are, however, under preliminary consideration, and were at the time of the trial; it will be only a question of time before the political and other difficulties are overcome and some large power developments are constructed on the Delaware River.

Now what is going to happen the next time, supposing New York City wishes to extend its water supply and take more water from the Delaware? The limit of diversion at which damage occurs has already been fixed by the

*Consulting Engineer, Boston, Mass., and Professor of Hydraulic Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Court in the present proceedings. What can be done? The city of Philadelphia, in all likelihood, will also need water, and while this will not be an interstate diversion it will require taking the water out of the river a considerable distance up the stream and not returning it until below Philadelphia, so that there will be a considerable stretch of river which will be adversely affected.

In the latter part of the case, witnesses of the state of New Jersey suggested a plan, referred to by some as the New Jersey plan, showing what they thought should be done in the present instance, and certainly in the future. That plan simply described was this: That all developments for diversions of water should contemplate the construction of large storage reservoirs up to full stream development, so that an amount of water could be passed downstream equal to that which was diverted. This means in the case of the Delaware, which can be developed to somewhat in excess of 2 cu. ft. per sec. per sq. mile, that 1 cu. ft. per sec. per sq. mile would always be permitted to flow downstream.

Is it not going to be necessary in the future to require what will be in effect the New Jersey plan? Any further diversion of water from the Delaware River beyond the amount of 440 m.g.d. will result in damage, in the opinion of the Supreme Court. If further diversions become large in amount — and testimony and exhibits in the case indicated that this was contemplated by both New York City and Philadelphia — these damages may become serious, unless some provision is made to minimize them.

The comprehensive scheme of development of the Delaware River suggested by the engineers of New Jersey contemplated not only the complete development of power, but also the development of the river for all other purposes — including navigation, recreation, sanitation, and the shellfish and other industries.

The great value of the power-development scheme is its ability to give a substantial return for much of the investment in dams and reservoirs and to help carry along the other resulting benefits. This feature is present upon many interstate streams besides the Delaware. The Connecticut River, for example, by power-reservoir developments upon tributary streams in Vermont and New Hampshire can be brought to a high regulated flow; at the same time the flood hazard can be reduced to a minimum.

The state of Vermont has recently completed a thorough study of power-storage development to solve its flood problems. Here again, it has been found that a comprehensive system of power-storage reservoirs, to be built by the power companies, will provide power at feasible cost and at the same time take care of the flood hazard.

Any necessary further diversion of water by Metropolitan Boston from rivers in western Massachusetts can, as far as compensation on the Connecticut River is concerned, readily be taken care of by reservoirs on tributaries in Vermont and New Hampshire.

Important interstate streams like the Delaware and Connecticut

should be studied as a whole and the best plan worked out to meet all demands for water — both for municipal water supply and other uses or needs.

In the Connecticut-Massachusetts case, damages were obviously insignificant, and no injunction was allowed. Nevertheless, the Master stated that in the future, if continued diversions resulted in substantial damage, the states still have recourse to the Court. It is also interesting to note that, in the Delaware case, the Master recognized that, at some future time, the findings should perhaps be modified in view of more complete information and experience.

Two of the objections to the New York plan, as it was suggested, were: first, that the amount of water to be released downstream, *viz.* 0.45 cu. ft. per sec. per sq. mile, was not adequate; and second, that if it was to be released far up in the headwaters of the Delaware, it would have little or no direct effect on conditions farther down at any given point. The deficiencies of the plan were recognized by the Master by increasing the amount of the flow to 0.5 cu. ft. per sec. per sq. mile and, still more important, by requiring as an index, not the point of release at the reservoir, but measuring points down the river, at Port Jervis and Trenton. It was stipulated that the flow must be maintained up to 0.5 cu. ft. per sec. per sq. mile, if possible, but the amount to be provided from the diversion areas was limited to one-third of their flow, or about 0.67 cu. ft. per sec. per sq. mile.

The Master and the Court both recognized, however, that these matters were subjects for some experimentation or trial, and that they might have to be modified in the light of experience.

These two findings of the United States Supreme Court in the Delaware River and Massachusetts cases have resulted in a fairly clear definition of conditions under which diversion of water from interstate streams may be permitted and quite justify the large amount of time and attention required in these cases. We are especially indebted to the author for his clear and complete analysis of the legal procedure and principles involved in these and other cases.

Discussion by Charles E. Ryder.*

It was the writer's privilege to be connected, in an advisory capacity, with the Pennsylvania Commission in negotiating the 1925 and 1927 compacts as to the water resources of the Delaware River, and his pleasure during these negotiations and the hearings in the Delaware River Case to be associated with the author, who so ably represented the state and city of New York. Certainly no one connected with the Supreme Court litigation or the Delaware River compacts is better able than the author to discuss intelligently and impartially the many engineering and legal principles established through these proceedings or to present the facts in such form

*Chief Engineer, Water and Power Resources Board of Pennsylvania, Harrisburg, Pa.

as to make of his paper a most valuable source of reference in future cases where interstate waters are concerned.

The author's discussion with respect to "Interstate Compacts" was particularly interesting, and the writer is pleased to be able to say, as a result of almost constant contact with the proceedings, covering a period from 1923 to 1931, that he holds the same views as to the superiority of compacts over court litigation in settling questions such as were involved in the allocation and use of the waters of the Delaware River. In cases settled through court decision, one side or the other will not receive all for which it contends, else there would be no contention, and while the decision of the court is based on principles of justice, the fact remains that there is liable to be less satisfaction to all the contending parties than is attainable under the meeting of minds of broad visioned commissioners in constructively negotiating a compact. As the author so clearly demonstrates, compact negotiations necessarily involve compromise on the part of all the interested parties, and success or failure depends largely upon the caliber of the commissioners, their attorneys and engineers, engaged in the negotiations.

The recent decision of the Supreme Court has settled certain very important principles relative to the use and allocation of interstate waters, but it did not include other matters, of importance to the three states, covered under the previous compacts, and hence the writer is of the opinion that another compact between the states of New Jersey, New York and Pennsylvania will eventually be adopted, probably sooner than most people realize at this time. This is based also upon the writer's belief in the certainty that the Upper Delaware River and its tributaries will eventually be needed and used for domestic water supply purposes in the growing metropolitan areas in all three states, with the possibility that they may combine in developing such supply.

Prior to the first compact negotiations in 1923, a study was made in the writer's office of the possibility of developing the main Delaware River as a source of future gravity water supply for the city of Philadelphia and for the area in eastern Pennsylvania between the Lehigh River and the city of Chester, by the construction of a dam across the river, at or near Waupack Bend, which would form a reservoir about 24 miles long, extending to a point just below Port Jervis. Without going into further details, it need only be said that the investigation seemed to show that the scheme had considerable merit and was superior in many respects to previous plans for developing tributaries of the Upper Delaware and Lehigh Rivers. Due possibly to the prohibition against dams across the Delaware River by the Pennsylvania-New Jersey treaty of 1783 and the interstate nature of such development, this scheme to the writer's knowledge had not been suggested previously. The compacts of 1925 and 1927 would have made possible such development and Mr. S. M. Swaab, Consulting Engineer to the Mayor of Philadelphia and the city's engineering advisor to the Pennsylvania

Compact Commission, made more elaborate studies which he later brought to the attention of the city. Such development is not possible under the recent Supreme Court decision and the writer believes could only be accomplished through compact between New Jersey and Pennsylvania, possibly with the purpose of joint development with additional storage provided on tributary streams. The studies already made seem to indicate that the main Delaware River itself must be considered as a possible source of future domestic water supply for the city of Philadelphia.

In addition to authorizing the construction of dams across the Delaware River, the compact of 1927 provided other advantages which are not afforded or are left undecided under the Supreme Court decision. Among these was a provision for using the channel of the river as a carrier of water that had been or might thereafter be developed by storage for any purpose on the tributaries or in the main river; this water was earmarked as belonging to the state by which the development was made. Such water was designated "water in transit" which could be removed at any point lower down the river. As there are storage possibilities on the tributaries in each state, this provision of the compact would have benefitted any development for diverting water from the main channel of the Delaware River to the extent of the releases from storage reservoirs within the state undertaking such development.

The Upper Delaware River, above the head of tide at Trenton, is an unusually clean stream, and the Commissioners of the three states recognized the importance of incorporating in the compacts suitable provision for preserving and improving the river for use as a source of domestic and municipal water supply. The city of New York is obliged under the Supreme Court decision to treat the sewage and industrial wastes from Port Jervis to a high degree, which with the release required from its storage reservoirs will further improve the present sanitary conditions of the river. The maintenance or improvement of the quality of the water is, however, not guaranteed under this decision, as it was under the terms of the Delaware River compacts.

Still another benefit under the compact, which will not accrue through the decision of the Supreme Court, would have resulted from the designation of the order of importance and public value of water, namely, (a) domestic and municipal, (b) sanitation, (c) industry and power, and (d) navigation. The compact provided that any property and rights to the use of, or in, water, though devoted to a public use, might be taken and condemned in favor of any public use higher in the order of importance as previously set forth. The compact also provided for the condemnation of property necessary for the construction, maintenance and operation of any dam in the Delaware River and for the condemnation of any rights to the use of, or in, water necessary to effect any allowable diversion from any tributary or from the channel of the Delaware River.

The 1927 compact provided for the creation of a Tri-State Delaware

River Commission empowered, *inter alia*, to observe the operation of all developments under the compact; to issue orders to secure compliance with the provisions of the compact coming within its jurisdiction; to institute the necessary proceedings to enforce its orders and terms imposed in any diversion, authorization or approval made by it; to make, modify and change schedules for allowable diversions from the channel of the Delaware River; to make annual reports for the information of the legislatures of each state; and in general to act as a body for the purpose of avoiding disputes and litigation between the states. In a minor sense, the River Master advocated by the Commonwealth of Pennsylvania in the proceedings before the Supreme Court, would have acted in a somewhat similar capacity, although the powers and duties of the commission would have been much broader. A permanent commission, as set up under the compact, with each state entitled to one vote, and every decision, authorization or approval requiring a unanimous vote of all the states, would have been able to settle to the satisfaction of each state many questions which otherwise could have been settled only through litigation, with its attending expense and delay.

The Commonwealth of Pennsylvania, in its "Statement of Interest and Relief Desired," stated that a number of municipalities of the commonwealth are at the present time obtaining a water supply from the Delaware River and its tributaries and that the river and its tributaries will be the necessary source of increased supply to these and other municipalities lying within the Delaware River Basin; also that the city of Philadelphia has caused studies to be made from time to time by its engineering forces and by consulting engineers employed for the purpose, of possible sources for its future water supply and that, among other plans for development, the use of the Delaware River above the head of tide at Trenton has been advocated and the need for future water from the Upper Delaware River or from tributaries of the Upper Delaware has been recognized. During the hearings before the Special Master, testimony was offered to show that within a period of fifty years the city of Philadelphia and eastern Pennsylvania would need 750 m.g.d. of water and that such supply could be obtained from tributaries of the Delaware River. In its brief before the Special Master, the Commonwealth contended that the city of Philadelphia and eastern Pennsylvania should be allotted presently 750 m.g.d. from the Pennsylvania tributaries of the Upper Delaware River as its fair and equitable share in the waters of that river.

With respect to this contention, the Master found that the relief asked for was not embraced within the "Statement of Interest and Relief Desired," and that "while it definitely appears and I so find that there is great dissatisfaction with the present water supply of the City of Philadelphia and that qualified engineers and experts have recommended that Philadelphia resort to upland sources for a purer supply, yet, as heretofore stated, I do not find that there is any definite project or definite plan of Philadelphia to resort to the Pennsylvania tributaries of the Delaware River."

The Master stated further "I am of the opinion, therefore, and so hold that I am without authority and jurisdiction to allot 750 m.g.d. from the Pennsylvania tributaries of the Delaware River to Philadelphia and eastern Pennsylvania, and that relief is denied without prejudice." The decree of the Court provided "the prayer of the intervenor, Commonwealth of Pennsylvania, for the present allocation to it of the equivalent of 750 m.g.d. of water from the Delaware River or its Pennsylvania tributaries is denied without prejudice."

The 1927 compact permitted each of the states to make use of a part of the waters of the Delaware River and its tributaries for the purpose of meeting present and reasonably prospective needs, and, subject to the provisions of the compact, each signatory state was authorized to divert water from any tributary of the Delaware River within that state or from the channel or from both, up to but not exceeding the following yearly amounts:

Pennsylvania — 328½ billion gallons, which total quantity is equivalent to an average of 900 m.g.d.;
New Jersey — 219 billion gallons, which total quantity is equivalent to an average of 600 m.g.d.;
New York — 219 billion gallons, which total quantity is equivalent to an average of 600 m.g.d.

The compacts, therefore, provided for a partial allocation of the waters of the main Delaware River and its tributaries to each of the three states, making possible an orderly and systematic development of the water resources in each state for domestic and municipal supply, thereby eliminating the possibility of creating out of the Delaware River Basin a competitive area, in which prior appropriation and use in one state might affect or limit subsequent development in another state.

The Court's decision in my judgment fully protects the interests of Pennsylvania in the water resources of the Delaware River, as the principles for which the states of New York and Pennsylvania were contending are now firmly established, and when the time comes, the city of Philadelphia and eastern Pennsylvania will be able to obtain an adequate water supply from the tributaries of the Upper Delaware River. This would likewise be true had the 1927 compact been ratified by the three states; in addition, the main river itself could have been utilized and the other benefits afforded by the compact secured, as the principles underlying it are the same as those established by the Supreme Court.

As a result of the writer's close association with the compact negotiations and court litigation, and from the knowledge he has gained of the future water supply needs in the several states, he is firmly of the opinion that within a comparatively short space of time another attempt will be made to negotiate a compact with respect to the water resources of the Delaware River, and that owing largely to the settlement of hitherto disputed principles, now established by the Court, such negotiations will be more likely to have legislative sanction than those previously attempted.

DISCUSSION BY W. L. STEVENSON.*

This discussion of Mr. Merriman's paper is limited to certain of its sanitary engineering phases. It shows why the catchment area of the Upper Delaware River provides ideal sources of water supply for urban centers near the sea, that such supplies can be impounded and diverted without any material damage to the sanitary condition of the Delaware and that measures for safeguarding and improving the sanitary quality of the waters of the Upper Delaware are already under way.

In this discussion the "catchment area of the Upper Delaware" is construed to mean that part in Pennsylvania above the Lehigh River and the corresponding part in New York and New Jersey.

Its elevation is sufficiently high to permit the delivery of water supplies by gravity to the urban centers below, thus eliminating, in perpetuity, pumping which is necessary when nearby low-level sources are used. The density of population on the whole area is relatively low, a part of the shed is practically uninhabited, being wild second-growth timber land, and on this catchment area there are very few sewered towns or industrial establishments, no coal mines or oil wells and but one narrow limestone belt at the lower end. These are the reasons that most of the streams of this area are relatively pure, soft and free from substances that cause offensive tastes and odors. They are, therefore, ideal sources of public water supplies.

The proofs of Pennsylvania in the Delaware River case showed that by impounding the flow of tributaries of this area 1 750 m.g.d. of good water can be obtained, with ample additional water available from impounding reservoirs for release to augment low flows of the Delaware, under the Pennsylvania plan.

Field traverse of tributaries draining the Pennsylvania part of this area showed them, with very few exceptions, to be free from any artificial pollution, and so, in accordance with a state-wide policy, the Sanitary Water Board designated such streams as "Class A," of which more hereafter.

During the low stream flows and warm weather of the summer of 1929, Engineers of the Sanitary Water Board made a sanitary survey of the Delaware from Hancock, N. Y., to below Trenton, N. J. The results were in general agreement with a somewhat similar survey independently made about the same time by New Jersey. The Delaware was found to be in good sanitary condition, except at and immediately below Port Jervis, N. Y., at and below Easton-Philipsburg, Pa., at the confluence of Brodheads Creek (Stroudsburg, Pa., is four miles above the mouth) and at the Delaware Water Gap, Pa.

Self-purification and dilution had restored the Delaware to a fairly clean condition within a relatively few miles below Port Jervis and again below Easton-Philipsburg. The other two pollutions of the river at Dela-

*Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.

ware Water Gap and at the mouth of Brodheads Creek are wholly local and minor. The relatively good sanitary quality of the Delaware above Trenton is nearly the same as above Port Jervis, thus showing the great natural power of the present unregulated river to assimilate such pollution as it now receives.

Mr. Harrison P. Eddy, on behalf of New York City, showed that the impounding of tributaries at high stages of flow will have a negligible effect on the sanitary conditions of the Delaware, because at such times biological action is greatly retarded by the lower temperature and also because clean cool water contains a large quantity of dissolved oxygen. The experts agreed that, from a sanitary point of view, the critical season of the year is during times of low flow and warm weather, on account of lack of diluting water, lower oxygen content of the water and maximum biological activity. It, therefore, follows that if satisfactory sanitary conditions can be maintained in the Delaware during this critical summer period there need be no concern about sanitary conditions during the remainder of the year.

During the hearings, Pennsylvania submitted a rule for release of water from impounding reservoirs on tributaries based on the principle of maintaining or tending to maintain a minimum flow in the Delaware at Port Jervis and Trenton of not less than 0.5 cu. ft. per sec. per sq. mile. This rule for release of compensation water was endorsed by the Special Master in his report and made a requirement in the decree of the Court.

Mr. Robert Spurr Weston, on behalf of Pennsylvania, determined the "population capacity" of the Delaware first under conditions found during the 1929 sanitary survey and then as conditions would have been (1) had New York been diverting 600 m.g.d. and (2) had Pennsylvania been diverting 750 m.g.d., New Jersey 400 m.g.d. and New York 600 m.g.d. (total 1 750 m.g.d.) with, in both cases, compensation water being discharged from impounding reservoirs under the Pennsylvania plan of release. His testimony showed this would result in 35.8 per cent. increase in river "population capacity" over the 1929 natural conditions from Hancock, N. Y., to Trenton, N. J., when either New York was diverting 600 m.g.d. alone or with all three states taking a total of 1 750 m.g.d. as previously stated; about 18 per cent. increase from Port Jervis to Trenton under the same conditions and 8.8 per cent. increase from Easton to Trenton with New York alone taking and 1 per cent. increase in the same stretch of river with all three states taking.

Thus it appears that, under the Pennsylvania plan of impounding and release of compensation water, 1 750 m.g.d. of water can be utilized for water supply purposes from tributaries of the Upper Delaware without any material sanitary harm to the river and that, under most combinations of diversions, the releases, under the Pennsylvania plan, will materially increase the "population capacity" of the Delaware under the most adverse condition of low flows and warm weather which, be it remembered, may occur during the recreational season.

It was also shown by Mr. Weston that the more uniform flows of a regulated river would be a benefit to sanitary conditions during the summer recreational season, as the impounding of summer showers would tend to prevent scouring out the present sludge deposits at and immediately below Port Jervis and also would tend to prevent disturbance of the beneficent biological zones in the river for its self-purification.

It seems passing strange that the plaintiff would aver alleged benefits from an unregulated river when the summer showers stir up sludge deposits at Port Jervis and result in befouling the beaches below, because it is the policy of the New Jersey Department of Health to require treatment of sewage discharged to the Delaware in order to abate just such stream pollution.

The departments of health of New Jersey and Pennsylvania, in 1922, mutually desiring to maintain and further improve the sanitary condition of the Delaware, executed an agreement providing, *inter alia*, for the treatment, to a high degree, of sewage discharged to the river above Easton-Philipsburg and efficient sedimentation below that point. The Delaware River Compact of 1925 included a sanitation clause containing the same requirement, and this compact was executed by New Jersey commissioners duly appointed by the Governor, pursuant to authority of the legislature of the plaintiff state.

The Department of Health of New York State held like views toward the Upper Delaware and executed a supplemental agreement with the Pennsylvania Department of Health including a high standard for treatment of sewage and industrial waste discharged to the river above Tri-State Rock (shortly down stream from Port Jervis). Consistent therewith, the city of New York in its brief to the Master voluntarily offered that a requirement for the treatment of pollution at Port Jervis be precedent to the diversion of water from New York tributaries, and the Master so recommended to the Court who placed in its decree a mandate that the sewage of Port Jervis "shall be treated to such an extent as to effect a reduction of 85 per cent. in the organic impurities" and disinfected "so that the *B. coli* originally present in the sewage shall be reduced by 90 per cent." also, that industrial wastes shall be treated so as "to render the effluent practically free from suspended matter and non-putrescent."

The Master in his report to the Court stated "After the waters of the Delaware River leave New York State, it is then the problem of Pennsylvania and New Jersey to see to it that the waters are not unduly polluted from sources on the New Jersey side and the Pennsylvania side." But even before the submission of testimony in this case, the Sanitary Water Board of Pennsylvania had adopted this very same policy. After consideration of the 1929 survey of the river and the designation of Pennsylvania tributaries as Class A, that Board adopted resolutions on March 25, 1930, including, *inter alia*:

WHEREAS, It is to the best interests of the Commonwealth of Pennsylvania that the Delaware River above the head of tide at Morrisville shall be maintained in its present wholesome state and improved from year to year as may be practicable and feasible without placing an undue burden upon the citizens of this Commonwealth, and

WHEREAS, The tidal portion of the Delaware River, although not in the cleanly condition of the river above Morrisville, nevertheless is used for domestic, municipal and industrial purposes and should therefore, be improved from year to year as may be practicable and feasible, therefore be it

RESOLVED, That the Sanitary Water Board hereby reiterates its policy of preserving the present wholesomeness and sanitary condition of the non-tidal portion of the Delaware River and also declares its intent to bring about in a reasonable and practicable manner the maintenance of all the Delaware River in a sanitary condition at least equal to that which now obtains and so far as is reasonable and practicable and to the limit of the authority of said Board and the Commonwealth of Pennsylvania, to improve its sanitary condition throughout its entire length.

Also:

WHEREAS, Agents of the Sanitary Water Board have made inspections of streams draining this area which indicate that over 90 per cent. of the length thereof are now relatively clean, and

WHEREAS, These tributaries of the Delaware River are well suited, and most likely will be needed, for the future water supply of densely populated and highly developed areas in eastern Pennsylvania, therefore be it

RESOLVED, That the Sanitary Water Board hereby reiterates its policy of preserving the present wholesomeness of such part of the aforesaid tributaries as are now relatively clean and also declares its intent to bring about, in a reasonable and practicable manner, the clarification and oxidation of sewage and industrial wastes discharged to other parts of the aforesaid tributaries, to the end that, so far as practicable, all the tributaries of the Delaware River within Pennsylvania draining the aforesaid area shall ultimately become Class A streams as the same are defined in the revised resolution of the Sanitary Water Board for classifying streams.

In accordance with these resolutions, the Sanitary Water Board issued mandates to Delaware Water Gap, Stroudsburg and East Stroudsburg to abate sewage pollution and took up the matter of suitable treatment of industrial wastes with the few concerns responsible for stream pollution in that neighborhood. In due course and in a reasonable manner, it is forecast that abatement will be made of all pollutions of Pennsylvania streams in this catchment area of the Upper Delaware River.

The Delaware, below Trenton, presents an entirely different sanitary problem than that of the upper river. The Lower Delaware is tidal, relatively deep, has a great superficial area, and upon its banks are large sewered cities and manifold and diverse industries producing waste waters. Therefore, the Delaware below Trenton now is and of necessity will remain a main drainage stream for the cities, towns and industries along its banks.

Progress is being made toward ultimately meeting the standards of efficient sedimentation of sewage set up in the 1922 Pennsylvania-New Jersey agreement for the tidal part of the river. The cost to such cities as Trenton and Camden in New Jersey and Chester and Philadelphia in Pennsylvania to treat their sewage to the high degree needed and required

at Port Jervis would be an unduly heavy financial burden, not commensurate with benefits attained. Furthermore, most of the sewer systems of towns on the tidal Delaware are of the combined type; hence, storm water carrying sewage, industrial wastes and street wash must, without treatment, overflow to the river during rain storms. It, therefore, follows from a practicable and economic viewpoint that the best that can be hoped for the tidal Delaware is to put and maintain it in a condition of such cleanliness that, at all times and in all places, there will be no nuisance to sight or smell. This can and will be accomplished by the suitable treatment of sewage and industrial waste discharged to the tidal river, by the dilution available in the great volume of tidal water, the long time of transit from place to place along the river due to the oscillations of the tides, and by the re-aëration of the river from the atmosphere.

After careful study of this phase of the case Mr. Weston, on behalf of Pennsylvania, showed that the effect of any change in fresh-water discharge at Trenton upon the self-purifying capacity of the lower Delaware River will be too small to estimate. The population capacity of the tidal prism is so largely dependent upon oxygen, and the amount of oxygen is so largely dependent upon re-aëration of the river water by absorption of oxygen from the atmosphere that the small changes in quantity of oxygen brought to the head of tide caused by takings and releases on tributaries of the upper river are such a small percentage of the amount of oxygen which the lower river absorbs from the atmosphere that the sanitary effect upon the tidal river of the changes in flow of the upper river is too small for consideration.

Therefore, the utilization of the clean tributaries of the Upper Delaware for sources of water supply, as submitted in evidence by Pennsylvania, will not adversely affect the sanitary condition of the tidal part of the Delaware River.

However, the tidal Delaware is not, and probably never will be, an ideal or even a satisfactory source of public water supplies, and while supplies derived from it may be bacteriologically safe as delivered to consumers and do not cause disease, still the hard and unavoidable fact remains that such drinking water is a manufactured product and actually "purified sewage" to a greater or less degree dependent upon the location of the water-works intake.

The Master in the Delaware River case, after hearing testimony of distinguished water-works engineers, wrote in his report to the Supreme Court:

> The modern tendency is to obtain for municipal supply the purest water possible and to make this water better and not to obtain less desirable water and render it acceptable by treatment and purification, though insuperable economic considerations frequently compel the latter course.

The prayer of the Commonwealth of Pennsylvania to the Supreme Court of the United States in the Delaware River case for a present allot-

ment of 750 m.g.d. of water from the clean tributaries of the upper Delaware was dismissed without prejudice, one reason being that Philadelphia and Eastern Pennsylvania have not yet adopted nor the state approved such a water supply plan.

However, the decision in this case appears to mean that, in due season, Pennsylvania can and will obtain by gravity an adequate volume of clean, soft water from Pennsylvania tributaries of the Upper Delaware and that this can be done without damage to the sanitary condition of the Delaware River.

Discussion by Solomon M. Swaab.*

The Sovereign Commonwealth of Pennsylvania requires no defense for the position she has taken in the recent litigation concerning the Delaware River. Pennsylvania was interested in conserving the waters of the Delaware River generally and those to which she may rightfully be said to be entitled particularly. She had, therefore, no ulterior motive in participating, not on the side of either of the principals, but as Intervenor, solely in her own interest, in the suit which had been instituted against the state of New York by the state of New Jersey, to restrain the former from using the flood waters that originate on her own soil. Pennsylvania was and is interested in protecting her rights. To enable her to do this, she requested from the Supreme Court of the United States the right to intervene and was permitted to do so.

The expression, "conserving the waters of the Delaware River," is here used in its broadest sense, because the writer's personal concept of what this expression means may differ from that of others. Of course, it is intended to mean the biggest and the broadest use of these waters in the interest of the people, — not alone the citizens of Pennsylvania, but of the other states washed by its waters as well, — through a system of regulation and control, which will afford the greatest good, for all time, for all concerned and for all purposes, not permitting the waters to run out to sea, as they have from time immemorial, accomplishing no good whatever, as remains the case today, and is, in fact, a condition which New Jersey tried to saddle on us for all time.

Pennsylvania's attitude towards the New York allocation was based on the firm and sincere conviction, — demonstrated to the satisfaction of the Court, — that there is sufficient water available under the Pennsylvania plan of storage and release, for all three states.

Pennsylvania was prepared also to prove before the Master in the Delaware River case, and actually did prove: (1) that the use of water for domestic purposes was its highest use; (2) the necessity for the adoption of the doctrine of equitable apportionment, as opposed to the literal interpretation of the old common law doctrine of riparian rights; (3) that the

*Consulting Engineer, Philadelphia, Pa.

boundary lines between the states are not to stand in the way of promoting the health, happiness and prosperity of the people of our country. While the third proposition was not literally questioned in the trial, it entered into this matter probably to a larger extent than was evidenced on the face of the proceedings.

Pennsylvania, through duly accredited representatives, had, moreover, evinced her willingness to proceed to an equitable apportionment of the flood waters by joint agreement, or compact, between the states, on two occasions prior to the decision of the Supreme Court. Unfortunately, so-called political expediency and supposed interference with corporate vested rights prevented ratification by the state legislature on both occasions. This occurred before the principle of equitable division was laid down as a fixed principle by either of the recent decisions of the Supreme Court of the United States. In the Compact of 1927, the allocation made by the three states was based on this principle and, therefore, anticipated the decision of the Court.

The interests of Philadelphia and Eastern Pennsylvania, in the Delaware River Case, may be briefly summarized as follows:

(1) To give the Metropolitan District of Philadelphia and Eastern Pennsylvania a freer opportunity to work out their own water supply problem by stopping competition for the desirable upland sources; (2) to better the conditions in the Delaware River during the critical dry-weather periods when flows are low; (3) to provide the largest practical volumes of water for the maintenance of good, sanitary conditions in the lower river; (4) to better safeguard the use of the lower river for industries; (5) to provide that everyone concerned may enjoy his rights to the utmost, consistent with the rights of others.

Since the Court has ruled that the use of water for the purposes of water supply is "the first and most important use of water," it is a foregone conclusion that the cities of Eastern Pennsylvania, including Philadelphia, lying within the watershed of the Delaware River, would naturally seek water supply from that source because of its copiousness and character. For those cities that lie directly on the river, there can be no more copious, constant, nor economical source of water supply, suitable for domestic purposes, than the Upper Delaware River and its tributaries.

In the Delaware River Case before the Supreme Court of the United States, the state of New Jersey contended against the diversion of water for water supply purposes by the city of New York, because it held it would interfere with navigation, power production, recreation, manufacturing, fishing, agriculture, the oyster industry and other desirable or necessary processes and only incidentally with water supply. As previously stated, Pennsylvania considers all of these subservient to water supply,—and the Court has established them so to be in this case. Even should it be discovered that more material damage than was established in this trial would be done any or all of these factors, by the most extensive and liberal, al-

though not prodigal, use of the water, there would be no justification for its curtailment as a source of water supply for the cities of New York, Northern New Jersey and Metropolitan Philadelphia, — even in order to maintain the integrity of the river for all of the other purposes for which it may be used.

Undoubtedly, if the river water can be utilized for purposes of water supply and, incidentally, for these other purposes, there can be no objection on the part of anyone to such a course of procedure; but as it becomes necessary to sacrifice its use for water supply and to make this use secondary to all of the other uses, there will be found very little support for such contention in the state of Pennsylvania. In fact, such has been the ruling of the United States Supreme Court.

Specifically, Philadelphia's interest lies in a future water supply from a point so far beyond the reach of tide as to be beyond the possible effect of contamination from this source; also to deliver this water, by gravity, as nearly as that may be done, into the present city reservoirs.

Philadelphia, for years past, has been manufacturing its drinking water. The raw material is a grossly polluted river water. This is taken from the tidal prism in the Delaware and from several points in the Schuylkill beyond the reach of the tide, although subject to pollution by the surface and sanitary drainage from the entire Schuylkill valley. This includes the washings from the culm banks in the coal region and manufacturing wastes from one of the most intensely developed industrial regions in the state of Pennsylvania.

The lower Delaware River water is polluted by the sewage of our own city, by that of Camden, and of other cities on the Delaware River above Philadelphia, and also by that arising from the shipping in the river. Philadelphia is making strenuous efforts to keep its sewage out of the river by building intercepting sewers along the waterfront and by sewage treatment. Philadelphia and New Jersey have an agreement, since 1922, as to the degree of treatment to be provided for sewage effluents.

The entire water supply of Philadelphia is filtered through slow sand filters and treated with liquid chlorine. Some of it is treated in comparatively rapid filters, using aluminum sulphate as a precipitant. Excepting that at certain times the water may possess the familiar undesirable tastes and smells possessed by over-chlorinated waters, it is generally rated as good water, as shown by the comparative lack of typhoid fever and other water-borne intestinal diseases in Philadelphia since complete treatment of the city's water supply.

It is scientifically possible to take Delaware River water, or, any other contaminated water, — even crude sewage, — and render it hygienically fit for drinking and acceptable to sight; but it shouldn't simply be a matter of economy whether we use for domestic purposes such a product or whether we drink water as pure as it is to be had in Nature. It is undeniably true that water purification processes are intended to make good water better,

rather than to enable poor water to be drunk with impunity, utterly disregarding its origin.

Not alone to satisfy esthetic conditions, but also because of human frailties and because no mechanical apparatus can ever be said to be perfect, water used for domestic purposes should come from unpolluted rather than polluted sources. Purification processes have been so highly and exquisitely and scientifically developed as to permit water which has been repeatedly contaminated, purified and used, to be drunk with comparative safety, as far as we know. Undoubtedly, this is not as it should be. Like the process sometimes figuratively called "sitting on a volcano," it is, or may be, fraught with extremely calamitous consequences. San Vicente, the patron saint and protector of drinking water, has heretofore amply protected us and seemingly allowed us to abuse this substance, with absolute disregard for the potential danger which lurks in it. Still the more practical of us will hesitate, in the face of known facts, to take undue chances with a substance which shares, with bread, the staffship of life, and without which life is impossible.

However, no degree of treatment to which waters can be subjected can ever remove from them the taint lying in the fact that they have passed through the human intestinal tract and that, as they are delivered to the people, they have simply been reconditioned. This idea must necessarily be so revolting to the public taste and so gross a perversion of what, it is generally considered, the public is entitled to, that it must ultimately demand and receive water which has not been defiled. Undoubtedly, it is true, as Master Burch, in the Delaware River Case, said, after hearing the testimony, that:

> The modern tendency is to obtain for municipal supply the purest water possible and to make this water better, and not to obtain less desirable water and render it acceptable to treatment and purification, though insuperable economic conditions frequently compel the latter course.

Several years ago, in discussing the same subject, the writer maintained that, solely as a matter of economy, municipalities have continued to use sources of water supply which have long since outlived their usefulness. Sources of supply which, at one time, may have been adequate and satisfactory from the existing viewpoint, and on which there have been expended large sums of money for original construction, subsequent extension and maintenance, have continued to be used years after their undesirability had been established beyond cavil. The sole considerations which prompted their continued use were (1) the lack of desire to change long established customs and (2) so-called economic considerations, which would prevent the further use, in whole or in part, of supplies considered adequate. Rather than taking water from other sources, however desirable or even necessary this may be found to be, such municipalities have continued to spend money on the maintenance and further extension of less

desirable sources. The writer firmly believes, however, that a community which is approaching maturity will not continue longer with makeshifts which it was forced to use during its early years when better supplies were economically beyond its reach.

There are other reasons why Philadelphia cannot continue to take water from the Lower Delaware and Schuylkill rivers.

In reporting to the mayor of Philadelphia on this subject (1924), the writer made the statement that with the continued intensive, industrial development along the shores of the Delaware below the head of tide, the day would come when it would be impossible to continue to use the water of the Lower Delaware as our domestic supply. He advised the mayor, on that occasion, that the critical season of the year is during the times of low flow and warm weather, on account of the lack of diluting water, lower oxygen content and maximum biological activity. Under these conditions, the time was not far distant when the water of the Lower Delaware would be adjudged unfit for human consumption. The supply must then necessarily be abandoned and recourse had to the more distant supplies of the Upper Delaware and its tributaries.

As the population increases, the discharge of sewage and waste increases correspondingly. However efficiently both are treated, the taste and smell of purified sewage and industrial waste become more and more noticeable, until they become obnoxious. The writer, therefore, believes that in the end the association of these disagreeable properties, viz., objectionable taste, smell and visible pollution, especially when we consider their source, together with other characteristics like hardness, will eventually cause the abandonment of the Schuylkill and the Lower Delaware for the more agreeable, cooler, softer, safer and purer upland waters.

Should the people still be of the opinion that they cannot afford the more desirable sources, the reasons previously given will ultimately preclude the use of the Lower River for domestic supplies and will force us to go to the Blue Mountain sources. Herein lies the justification for the interest which Pennsylvania has manifested in the Delaware River Case, for, undoubtedly, one of her chief functions is to provide water for the people who live on her soil. Promotion of their health, happiness and general prosperity entitles them to the utmost consideration in these matters.

The Commonwealth of Pennsylvania, recognizing the adequacy of the Delaware River, under the Pennsylvania Plan, to provide water supply for certain cities within the states of New York and New Jersey and the Commonwealth of Pennsylvania, took the only possible stand in the matter of the proposed allotment to New York City, but, for the purpose of safeguarding all concerned, in the "Brief for the Commonwealth of Pennsylvania, Intervenor," under "Conclusions," was inserted the following:

> Any present allocation of the Delaware River water to the state and city of New York should not constitute a prior appropriation, but should be chargeable against their fair and equitable share in said waters.

and in the "Report of the Special Master," in the "Recommendations for a Decree," it is stated, in paragraph 5:

> Providing that the diversion herein allowed shall not constitute a prior appropriation and shall not give the state of New York and city of New York any superiority or right over the state of New Jersey and Commonwealth of Pennsylvania, in the enjoyment and use of the Delaware River and its tributaries.

and the "Opinion of the Supreme Court of the United States," paragraph 2, as delivered by Mr. Justice Holmes, regarding this, reads as follows:

> The diversion herein allowed shall not constitute a prior appropriation and shall not give the state of New York and city of New York any superiority or right over the state of New Jersey and the Commonwealth of Pennsylvania, in the enjoyment and use of the Delaware River and its tributaries.

In the "Brief for the Commonwealth of Pennsylvania, Intervenor," it is further stated, under paragraph 4, "Conclusions":

> The Pennsylvania Plan of Impounding and Release should be adopted because it is the best plan under the conditions of taking, and permits all three states to take their fair and equitable share of the waters of the Delaware River and its tributaries, when and as required, without causing substantial damage to any interest.

and in the "Report of the Special Master," under the "Recommendations for a Decree," paragraph 4-b, we read as follows:

> At any time the stage of the Delaware River falls below 50 c.s.m. at Port Jervis, New York, or Trenton, New Jersey, or both (50 c.s.m. being equivalent to a flow of 1 535 c.f.s. at Port Jervis and 3 400 c.f.s. at Trenton), water shall be released from one or more of the impounding reservoirs of New York City in sufficient volume to restore the flow at Port Jervis and Trenton to 50 c.s.m., provided, however, that there is not required to be released, at any time, water in excess of 30 per cent. of the diversion area yield; and the diversion area yield having been ascertained to be 2.2 c.s.m., the maximum release required shall be 30 per cent. of that amount, or .66 cubic ft. per second per square mile of the areas from which the water is diverted.

and the "Decree of the Supreme Court of the United States," previously mentioned, confirms the Master's recommendation in the adoption of the Pennsylvania Plan of Impounding and Release, the details of which have just been given.

This now clears the way for the cities in Eastern Pennsylvania, including Metropolitan Philadelphia, to seek an allocation which, in the opinion of Mr. Justice Holmes, previously quoted, was "denied without prejudice." To quote the language of the Special Master:

> There is no present or authorized plan of Pennsylvania or Philadelphia to take waters from the Pennsylvania tributaries of the Delaware for Philadelphia municipal supply or for the supply of Eastern Pennsylvania. The judicial power of the Court, under the Constitution, extends only to actual cases and controversies, and the Court is without power to render a declaratory judgment to the effect that in the event the city of Philadelphia and Eastern Pennsylvania should desire to take water from the tributaries of the Delaware, they would be entitled to 750 m.g.d.

The subject of a future water supply for Philadelphia has been con-

sidered for many years; an upland supply was considered as long as sixty years ago. However, as far as Philadelphia is concerned, it has never been able to secure the money required for providing such supply. Therefore, the city has had to be content to use the waters of the Lower Delaware and Schuylkill rivers for water supply purposes. Eventually, the city of Philadelphia will have to secure the money for this purpose, outside the borrowing capacity, as have other large cities in this country.

In a report entitled "View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water" by Henry Latrobe, Engineer, dated December 29, 1798, there occur the following paragraphs:

> The nearest waters to the city of Philadelphia are those of the Delaware and Schuylkill, I conceive them both to be wholesome, for reasons which I will mention in a postscript in order that I may not interrupt this consideration of the principal object.
>
> It is evident that the exertions of only seven months cannot, in this country, bring water from a greater distance.
>
> In choosing between waters of the Delaware and Schuylkill, the following considerations occur:
>
> (1) In favor of the Delaware: It is true that works erected upon the margin of the river would supply water to the city immediately, from the river upwards, and save all the expense which must, in the other case, be incurred between the Schuylkill and the Center Square.
>
> (2) Against the Delaware will operate the impurity of its water, which is subject to a strong running flood tide, and which must be supposed to be contaminated by the decayed vegetables of the marshes over which it passes; independently of the filth thrown from the numerous vessels lying along the wharves or running into it from the public sewers.
>
> (3) In favor of the Schuylkill: The principal circumstance is the uncommon purity of its water; its bed is everywhere narrow and rocky; its sources lie entirely in the limestone country, and the tide opposed to the center of the town does little more than raise the waters by accumulation.

These conditions prove conclusively that both the Delaware and the Schuylkill were, at this early date, given consideration. The fact of the matter is, however, that the Schuylkill sources were first developed and that subsequent extensions were largely made on the Delaware.

The water supply of Philadelphia has received the attention of many notable men on many notable occasions. Thus Benjamin Franklin, in a codicil to his will (July, 1788), provided the following:[1]

> . . . and having considered that the covering of the ground plat with buildings and pavements, which carry off most of the rain and prevent its soaking into the earth, whence the water of the wells must gradually grow worse, and in time be unfit for use, as I find has happened in all old cities, I recommend that at the end of the first hundred years, if not done before, the Corporation of the city employ a part of the hundred thousand pounds, (a Fund created under the will), in bringing, by pipes, the water of the Wissahickon Creek into the town so as to supply the inhabitants, which I apprehend may be done without great difficulty, the level of the creek being much higher than the city and may be made still higher by a dam.

To recite the history of the Philadelphia water supply would not be

warranted at this time. The writer needs only mention that the subject was given consideration by a Commission in 1899 which sought to improve and to extend the existing supplies. While no actual surveys were made in the Blue Mountain region, the surveys prepared by the City Water Department, under Colonel William Ludlow (later General), by Mr. Rudolph Hering, which were made as long ago as 1886, were used and were carefully considered.

The financial difficulties which confronted Philadelphia at the time of these surveys, and when the subject was reconsidered in 1899, exist at the present time also, probably intensified to a very large degree. These conditions required that a compromise be effected between a supply from the mountain sources, the cost of which could not then be negotiated, and the sources then (1899) in use, rectified to as great a degree as was then attainable with the amount of money available. This resulted in the Commission's recommending slow sand-filtration, whereby the waters of both rivers in front of the city could be reclaimed before distribution. As stated earlier in this paper, the entire supply of the city is, at this date and, in fact, has been for about twenty years, treated by filtration and chlorination before serving. Neither the Schuylkill nor the Delaware rivers, at the intakes are suitable for water supply according to any of the recognized biological and chemical standards. It should be said, however, that both waters, after treatment, are bacterially and chemically acceptable, although for sundry other reasons previously given, having to do principally with their origin and subsequent defilement, they are not at all desirable.

The water we are drinking may be compared with a man who has ventured "beyond the pale" and whose soul is seared with sin. He may reform and there will be "much joy in heaven" because of his reformation and repentance, but the sear is there and is irremovable.

Much could be said of the physical characteristics of the waters in question, their relative clarity, color, taste and smell. The Lower Delaware is only half as hard as the Schuylkill and the Upper Delaware is half as hard as the Lower.

There are many other considerations, but there is one which business men consider of paramount importance; this is the financial consideration. The writer has not referred to this previously except in an incidental way. Every gallon of water used today has to be pumped from the river level. This requires an expenditure for coal approximating $1 500 000 annually, the greater part of which will be saved if a supply from the Upper Delaware region is provided. If filtration is continued with the water from the Upper Delaware, which is likely, there will be a saving in the cost of filtration of upwards of $500 000 annually. If filtration is not used, the saving will be proportionately larger.

The amount of money to be saved annually by operating a water supply from upland sources is not given last because it is of least importance, but because other things affecting more closely the sensibilities of the people

than does the pocketbook, may reasonably be taken to have more weight (using the word in its mathematical sense), in deciding this subject.

The quantity of water to be provided for the metropolitan area of Philadelphia is dependent on two factors — (1) the population and, (2) the per capita supply. Neither of these factors is determinable with mathematical precision, and we have to use our best judgment in approximating them and even this may require modification at a subsequent date.

Metropolitan Philadelphia, in 1980, will possibly include parts of Bucks, Montgomery and Chester counties, as at present constituted, and Delaware County in its entirety. It will extend as far north as Bristol on the Delaware and as far south as the Delaware-Pennsylvania state line. It will very likely include Norristown and West Chester.

In area, it will be about the same size as Greater New York is today, and its population, as nearly as can be prognosticated, will be five and a half million.

In Philadelphia proper, the daily per capita supply required will probably be 160 gal. and outside the city probably 100 gal. When this is apportioned to the relative number of those who will continue to live and operate within the city proper and those in the suburbs, it may reasonably be supposed that there will be required, for the total population in 1980, 750 m.g.d.

For the cities in Eastern Pennsylvania, other than Philadelphia, which will use Delaware River water in 1980, as Easton, Allentown, Bethlehem, and other Lehigh Valley cities, there will be required another 100 m.g.d. It is quite likely that by this time Wilmington, Delaware, will seek to change its source of supply for a more copious one. If this is to come from Pennsylvania, an additional 50 m.g.d. will be required, making, in all, about 900 m.g.d. It is, therefore, safe to say that in the year 1980, there will be required in the neighborhood of one billion gallons daily to satisfy the demands of Eastern Pennsylvania; three-quarters of which must come from the Upper Delaware River. This can be augmented to make up the full amount by storage on the Perkiomen Creek, a tributary of the Schuylkill River, which is sufficiently high in elevation to supply the lower reaches of the district, by gravity.

It seems that whenever the future water supply of Philadelphia has been under discussion, the state of the city's finances has dictated the decision. The amount of money required to develop an entirely new supply is so large and the borrowing capacity, applicable to this one demand of the city's resources, is so limited that the city has always been required to act from the view of economy and expediency rather than from that of attainment of the best source.

Another advantage of a supply from the Upper Delaware region, which has not been stressed, is that if properly and conservatively used, it may be expanded almost indefinitely to provide water for domestic purpo-

ses for all of the cities in Pennsylvania likely to require water from that source.

Trenton Falls has generally been accepted as the line of demarcation between the Upper and the Lower Delaware. It is here that the waters gathered in the uplands come in contact with and mingle with those of the tidal prism in which most of the pollution occurs.

It doesn't require much of a stretch of the imagination to say that we in Philadelphia, now and for years past, have been drinking the "skim-milk," if nothing worse, and allowing the "cream" to be wasted.

The Upper Delaware River is one of those bounteous sources that Nature has provided to supply a commodity, without which existence is impossible, and for which, in this section of the country, there does not appear to be any alternative comparable source. We in Pennsylvania feel that sufficient water may be gathered from the flood flows in the Upper Delaware valley to provide water supply for the population of the three states which may require it, without causing undue injury to the other uses for which this water is subsequently required. We feel, moreover, that had New Jersey succeeded in preventing New York's taking, it would, by the same mandate, have prevented the Commonwealth of Pennsylvania from ever using any part of these waters for its own purposes; incidentally the same would have happened to those New Jersey cities which may ultimately require it. It behooves us, citizens of Eastern Pennsylvania and of Philadelphia in particular, now that this matter has been adjudicated, to prepare a satisfactory plan, with the acceptance of which such allocation can be made.

To summarize the decision of the United States Supreme Court in this case, so far as Pennsylvania is concerned: it establishes not alone our contention for a fair and equitable share of the waters for each of the three states, but it distinctly subordinates every other conceivable use of the water to that of "domestic supplies"; it establishes a rule for the impounding and release of waters so as to make it possible for each of the three states to take its quota from the river; it lays down the principle that the present taking by the state of New York shall not constitute a prior appropriation and shall not give it any superiority or right over the state of New Jersey and the Commonwealth of Pennsylvania in the enjoyment and use of the Delaware River and its tributaries; and it suggests the process on which is contingent a subsequent allocation to Eastern Pennsylvania.

This, to us, is the *summum bonum* of the decision.

DIVERSION OF INTERSTATE WATERS FOR DOMESTIC WATER SUPPLY.

LITIGATION AND UNITED STATES SUPREME COURT DECISION IN CASE OF CONNECTICUT VS. MASSACHUSETTS.

BY FRANK E. WINSOR.*

[*Read October 1, 1931.*]

SYNOPSIS.

There are 35 independent cities and towns, some portion of each of which lies within ten miles of the Massachusetts State House in the city of Boston. Of these cities and towns, 20 form the present Metropolitan Water District, and the remaining 15 are entitled to join the district whenever they see fit or necessity demands. These 35 communities have a total population of about 1 900 000 (Boston alone has about 800 000) of which about 1 500 000 are now supplied with water from Metropolitan sources by the Metropolitan District Commission, a state commission. The Metropolitan Water District was established by legislation in 1895, and about two years later, as provided in the law, the main collecting reservoirs, aqueducts, and other parts of the water works of the city of Boston and lesser works of other communities were taken over by the Metropolitan Water Board in the name of the Commonwealth. The Wachusett Reservoir on the Nashua River about 35 miles west of Boston, the Wachusett and Weston aqueducts and other appurtenant works required to distribute the water to the district were constructed by the Metropolitan Water Board mainly between 1895 and 1906. Since completion, the major portion of the water supply for the district has been from the Wachusett Reservoir.

The Metropolitan Water Board was succeeded by the Metropolitan Water and Sewerage Board in 1901 and by the Metropolitan District Commission in 1919. While all the works are held in the name of the Commonwealth and the Commonwealth advances its credit to finance the work, the district using the water actually pays all expenses of the system including construction, maintenance and operation. Each city and town in the Metropolitan Water District is required to include annually in its budget a sum sufficient to meet its share of the cost of water.

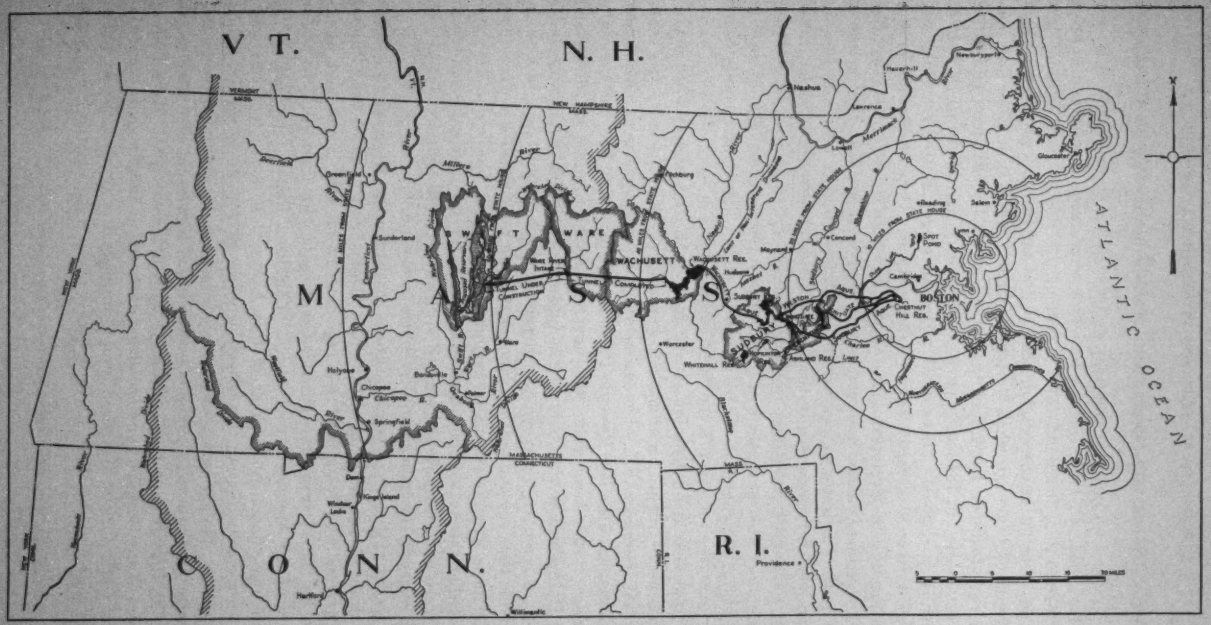
While the diversion of the waters of the Nashua River to the Metropolitan District was an interstate diversion, the river flowing through a portion of New Hampshire on its way to the Atlantic Ocean, no question involving interstate water rights was raised.

In 1926 and 1927, following some seven years of investigation, legislation was enacted providing for the next major addition to the Metropolitan

*Chief Engineer, Metropolitan District Water Supply Commission of Massachusetts.

water supply by bringing into the Wachusett Reservoir waters from the Ware and Swift rivers lying farther west and establishing the Metropolitan District Water Supply Commission, a construction commission, to carry out the project. The Ware and Swift rivers are tributary to the Chicopee River, which in turn flows into the Connecticut River at Chicopee, Massachusetts. The Ware, Swift and Chicopee rivers are non-navigable. The Connecticut River is an interstate stream forming in its upper reaches the boundary line between New Hampshire and Vermont, whence it flows across Massachusetts and Connecticut and empties into Long Island Sound. The river is navigable, in fact, to Hartford, Conn., about 28 miles below the mouth of the Chicopee. An insignificant number of small boats, practically all pleasure craft, navigate the river to Springfield, Massachusetts by passing through the small locks at Windsor Locks, Conn., at the head of tide water. Any water diverted from the Ware and Swift rivers for water supply of the Metropolitan District reduces the flow of the Connecticut River. In December, 1927, nine months after construction of works to divert the Ware River had been begun, the state of Connecticut through its Attorney-General took legal steps preliminary to bringing an action in the United States Supreme Court seeking to enjoin the Commonwealth of Massachusetts from making such diversions. On January 16, 1928, a bill of complaint was filed, and the Court on December 2, 1929, appointed Charles W. Bunn, Esq. of St. Paul, Minn., as Special Master to take evidence and report to the Court. The Special Master's report was filed on May 19, 1930, and the opinion of the Court was rendered on February 24, 1931. This opinion which sustained the Master in all important particulars dismissed Connecticut's bill of complaint "without prejudice to her right to maintain a suit against Massachusetts whenever it shall appear that substantial interests of Connecticut are being injured through a material increase in the amount of the waters of the Ware and Swift diverted by or under the authority of Massachusetts over and above the quantities authorized by the Acts of 1926 and 1927 as heretofore limited by the War Department," as described later in this paper. Under the opinion, Massachusetts is enabled to procure about 93 per cent. of the quantity of water from the Ware and Swift rivers contemplated by its legislation.

Some points in the report of the Master and in the opinion, significant as affecting future takings for municipal water supply, are recognition of the principle of equitable division of interstate waters; of domestic water supply as the highest use of water; and of the right of a community to choose an unpolluted source of supply in preference to a polluted source. The Special Master also recognized the importance of public opinion as a legitimate and important factor in influencing legislation.


V T.
N. H.
M A S S.
C O N N.
R. I.
ATLANTIC OCEAN
BOSTON
Springfield
Worcester
Providence
Hartford
Pittsfield
Lowell
Lawrence
Salem
Gloucester
Newburyport
Concord
Framingham
Holyoke
Chicopee
Northampton
Amherst
Greenfield
Fitchburg
Leominster
Gardner
Athol
Brattleboro
Bellows Falls
Keene
Nashua
Manchester
Portsmouth
Dover
Rochester
Haverhill
Newburyport
Wachusett Res.
Quabbin Res.
Ware River
Chestnut Hill Res.
Spot Pond
Framingham Res.
Whitehall Res.
Sudbury
Hultman Aqueduct
Metropolitan Tunnel
Connecting Conduit
Wachusett Aqueduct
Cochituate Aqueduct
Weston Aqueduct
Dike
Dam
Pumping Station
Gate House
Intake
Boundary of Metropolitan District
Boundary of Watershed
Boundary of Ware River Watershed
Boundary of Quabbin Reservoir
Boundary of Wachusett Reservoir
Boundary of Sudbury Reservoir
Boundary of Framingham Reservoir
Boundary of Chestnut Hill Reservoir
Boundary of Spot Pond
Boundary of Whitehall Reservoir
Boundary of Weston Reservoir
Boundary of Cochituate Reservoir
Boundary of Hultman Aqueduct
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Boundary of Wachusett Aqueduct
Boundary of Cochituate Aqueduct
Boundary of Weston Aqueduct
Boundary of Dike
Boundary of Dam
Boundary of Pumping Station
Boundary of Gate House
Boundary of

Brief History of Boston and Metropolitan Water Works.*

The first water works company in America was incorporated in Boston in May, 1652. In 1795–1796 an aqueduct corporation was formed to bring water from Jamaica Pond (now a part of the Boston park system) into Boston. The latter corporation reached the height of its prosperity about one hundred years ago when it supplied some 1 500 houses. The first publicly owned supply, from Cochituate Lake about 17 miles west of Boston, was established in 1848 after twenty-three years' agitation. In 1871–1878, following a seriously threatened water shortage, Boston's supply was pushed farther westward to the Sudbury River. Other communities surrounding Boston developed their own supplies from time to time as needed.

It became evident, however, some forty years ago that joint action in such matters as water supply, sewers and parks would be necessary to meet adequately and economically the needs of this closely knit district, made up of so many independent political entities, and a Metropolitan Sewer Commission was established in 1889, a Metropolitan Park Commission in 1893 and a Metropolitan Water Board in 1895. These three commissions have since been merged in the Metropolitan District Commission.

Preceding the legislation establishing a Metropolitan Water Board, an exhaustive report on additional water supply was made by the State Board of Health in 1895. The engineering investigations were made under the direction of the late Frederic P. Stearns, a past president and honorary member of this Association, and covered possible sources in Maine and New Hampshire as well as in Massachusetts. Following the recommendations of this report, the Wachusett Reservoir, some 35 miles west of Boston, was built thus continuing the policy of moving westward for water supply to the more sparsely populated regions of the state. This report also predicted that the next major addition to the water supply would come from the Ware and Swift rivers, located still farther west and some 50 to 65 miles respectively from the State House in Boston.

Under authority of the legislature, investigations were begun in 1919 by a Joint Board made up of the State Department of Public Health and the Metropolitan Water and Sewerage Board (this Board was later superseded by the Metropolitan District Commission) for increasing the water supply of the Metropolitan District. This Joint Board, for which X. H. Goodnough, honorary member of this Association, was Chief Engineer, made a recommendation to the legislature in 1922 to go to the Ware and Swift rivers. No action was taken, and another and independent investigation was made in 1924–1925, following which legislation was enacted on May 28, 1926 (Chapter 375 of that year) which created the Metropolitan District Water Supply Commission and authorized the immediate construction of works for the diversion, from a drainage area of about 98 sq. miles, of the waters of the Ware River in excess of 85 m.g.d. during the months,

*A general plan of the water supply system of the Metropolitan District is shown in Fig. 1.

December to May, inclusive, and, with the approval of the State Department of Health, during the balance of the year. The works authorized included a tunnel from the Ware River to Wachusett Reservoir, and the act

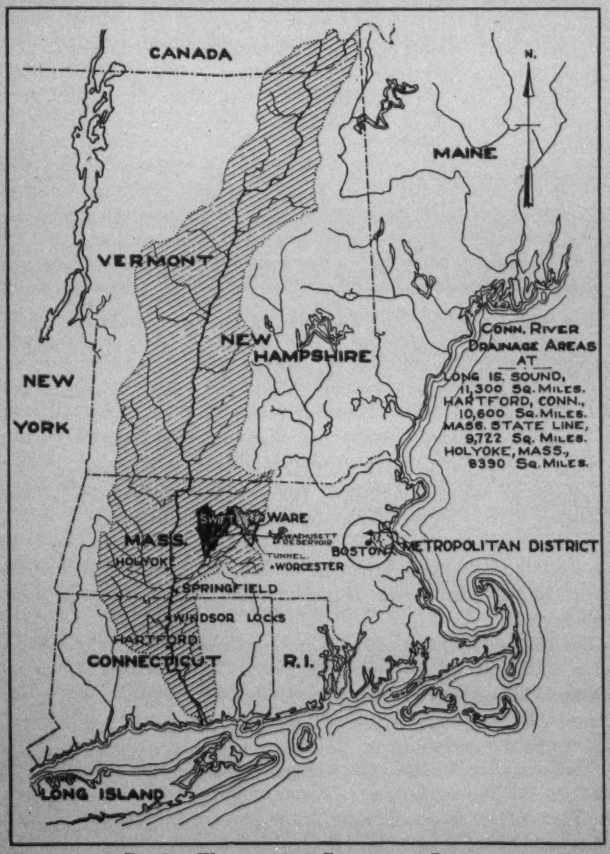

FIG. 2.— WATERSHED OF CONNECTICUT RIVER.
Showing portion from which prescribed diversions for Metropolitan Water Supply are permitted. September 1931.
Ware River at point of diversion 98 sq. miles.
Swift River at point of diversion 186 sq. miles.

specified that it should be "constructed at such grade and of such capacity and otherwise" as to "be used as a part of works that shall later be constructed for diverting into the Wachusett Reservoir the waters of the

Swift River, in substantial accordance with the plans and recommendations of the Joint Board on Water Supply Needs and Resources of the Commonwealth as contained in its report to the general court in the year 1922."

This act also directed the Metropolitan District Water Supply Commission to submit to the general court in January, 1927, "a draft of such legislation as it may deem necessary or advisable for the development of an adequate future supply from the Swift River." This draft of legislation was submitted, and the Swift River Act was enacted on April 26, 1927 (Chapter 321 of that year). Under this act a large storage reservoir will be constructed on the Swift River, and the tunnel to the Ware River begun in March, 1927, and completed in February, 1931, will be extended to the reservoir. This act authorizes the diversion of all of the waters of the Swift River from a drainage area of about 186 sq. miles, with the restriction that there shall be released at all times from the reservoir sufficient water to insure a flow of 20 m.g.d. at Bondsville, situated about 5 miles downstream from the dam.

Figure 2 shows the entire watershed of the Connecticut River and the relation to it of those portions of the watersheds of the Ware and Swift rivers from which water is to be diverted.

Relations with the War Department.

In a letter dated January 25, 1927, the District Engineer of the War Department at Providence, Rhode Island, whose jurisdiction covers the Connecticut River, stated that navigation interests were raising the question of the effect of the proposed diversions from the Ware and Swift rivers on navigation in the Connecticut River and requested copies of pertinent reports and legislative acts. Numerous data were supplied in response to this request.

The District Engineer of the War Department next advised the Commission under date of November 22, 1927, that relative to the proposed diversions, "The Chief of Engineers, United States Army, directs me to advise you that your operations in this connection must be authorized by War Department permit."

On November 30, 1927, the Commission made formal application to the office of the District Engineer for a permit for the diversion of the waters of the Ware River, in accordance with the terms of Chapter 375 of the Acts of 1926, and under the same date, a separate formal application for a permit for the diversion of the waters of the Swift River, in accordance with the terms of Chapter 321 of the Acts of 1927.

A public hearing on the Ware River application for permit was held by the engineers of the War Department at Springfield, Massachusetts on February 9, 1928, a few weeks after the filing of the Bill of Complaint by Connecticut.

Under date of March 19, 1928, the Commission was notified that,

"No objections will be interposed by the War Department to the diversion of flood waters of the Ware River exceeding 85 m.g.d. for the period October 15 to June 15 each year." This, in effect, gave the approval of the War Department to the diversion of the waters of the Ware River authorized by Chapter 375 of the Acts of 1926, with the restriction that no diversions be made during four months of the year, from the middle of June to the middle of October.

On May 17, 1929, the Commission was notified of the findings of the War Department relative to its application for a permit to divert the waters of the Swift River. These findings constituted approval of the diversions proposed by Massachusetts legislation, with the exception that it was required that there be released during the period from June 1 to November 30 each year, from the waters impounded in the Swift River Reservoir, a flow of 70 c.f.s. during each day when the flow of the Connecticut River at Sunderland, Massachusetts (drainage area 8 000 sq. miles) is less than 4 900 c.f.s. and more than 4 650 c.f.s., and that there be released when the flow is 4 650 c.f.s. or less 110 c.f.s. A flow of 4 900 c.f.s. at Sunderland is a rate of 0.61 c.f.s. per sq. mile of drainage area, and 70 c.f.s. discharged from the Swift River Reservoir (drainage area 186 sq. miles) is a rate of 0.38 c.f.s. per sq. mile. A flow of 4 650 c.f.s. at Sunderland corresponds to 0.58 c.f.s. per sq. mile, and 110 c.f.s. discharged from the Swift River Reservoir give a rate of 0.59 c.f.s. per sq. mile.

Since the engineers of the War Department determined that on the average, when the flow at Sunderland is at the rate of 4 650 c.f.s., low tide at Hartford is at mean low water, it is evident that the prescribed releases from storage will, under average conditions, prevent such slight decreases in navigable depth of the Connecticut River when low tide at Hartford is at or below mean low water as might otherwise be caused by diversions under the provisions of Massachusetts legislation.

Outline of the Case.

On July 11, 1927, the Attorney-General of the state of Connecticut asked for definite information on what Massachusetts intended to do on the Ware and Swift River projects, and all pertinent information available was furnished. On January 3, 1928, Connecticut filed a motion in the Supreme Court of the United States for leave to file a Bill of Complaint. This leave was granted, and the Bill of Complaint was filed on January 16, 1928.

Connecticut's Bill of Complaint. Connecticut's bill of complaint was summarized by the Court in the opinion as follows:

> The complaint alleges Connecticut and Massachusetts recognize the common law doctrine that riparian owners have the right to the undiminished flow of the stream free from contamination or burden upon it. Connecticut appears as owner of riparian lands and of the bed of the river and as *parens patriæ*. The proposed diversion will take water tributary to the Connecticut entirely out of its watershed, will impair naviga-

bility of that stream, will take flood waters and thereby cause damage to agricultural lands that are subject to yearly inundation. The Connecticut is now heavily burdened with offensive matter put into the river in Massachusetts and requires all the water that naturally comes down the river to prevent it from becoming a nuisance and menace to public health. The diversion will destroy property of Connecticut and of its inhabitants without due process of law and cause injury for which there is no adequate remedy at law. The diversion presently proposed is only a portion of that covered by the plan adopted by Massachusetts which includes the acquisition of the waters of other tributaries of the Connecticut.

Massachusetts' Answer and Amendments Thereto. Massachusetts' Answer was filed March 5, 1928, about two weeks before the War Department made known its findings relative to the proposed Ware River diversions and considerably over a year before it announced its findings with respect to the proposed Swift River diversions. Subsequent to the announcement of these findings by the War Department, Massachusetts amended its answer to give due consideration to the effect of the War Department restrictions.

In the words of the Court:

By its answer and amendments thereto Massachusetts denies that the proposed diversion will cause any injury or damage, and avers that the amount of water to be taken is negligible when compared with the flow of the river where it enters Connecticut, that an emergency exists in Massachusetts constituting a justification for a reasonable use of such waters, that the serious injury to the people of the Commonwealth if diversion be prohibited compared to the trivial damage possibly caused to Connecticut and its people if diversion is permitted should lead a court of equity to give substitutional relief rather than that specifically prayed, that Connecticut's contention that the diversion will interfere with navigation is not open in the absence of proof that Massachusetts has diverted or actually proposes to divert more water than is permitted by the War Department, that the proposed diversion is in all respects a reasonable use of the waters in question; and that the project will stabilize the flow of the river and result in benefit to Connecticut and the lower riparian owners.

Motion by Connecticut to Cite Chief of Engineers and Secretary of War as Parties Respondent. In April, 1929, Connecticut requested leave to file a motion which sought to join the Chief of Engineers, United States Army, and the Secretary of War as parties respondent in the case and to obtain an injunction against these officials of the War Department prohibiting them from acting upon the then pending application for a determination of the effect of the proposed diversion from the Swift River upon the navigable capacity of the navigable portion of the Connecticut River and ordering them to revoke their previously announced determination that (with certain limitations) the proposed diversion from the Ware River would have no adverse effect upon the navigable capacity of the Connecticut River.

This motion was based on allegations that the Secretary of War and the Chief of Engineers had no jurisdiction to determine that the proposed diversions would have no adverse effect on the navigation of the Connecticut River and that the determination in fact made by the War Department officials was erroneous.

Leave to Connecticut to file this motion was denied by the Court.

Motions by Connecticut to Dismiss Answer of Massachusetts or Portions Thereof. On December 2, 1929, Connecticut with leave of the Court filed a motion to dismiss the defendant's answer and a motion to strike out certain portions of the defendant's answer. These motions in the nature of demurrers to the whole answer or to specific portions of the answer raised generally the following contentions:

(a) That Massachusetts had not obtained the necessary authorization of its project from Congress or from the Secretary of War.

To this Massachusetts replied that the Secretary of War had "found that the project (with certain modifications) will not impair navigation upon any navigable water" and "that this action of the Secretary of War is the only federal action, if any, possibly required by the Navigation Act of March 3, 1899, inasmuch as Massachusetts is not erecting any structures in a navigable stream or (according to the War Department findings) altering the navigable capacity of any navigable stream."

(b) That the Massachusetts answer showed that the Massachusetts project revealed a diversion which would be an invasion of the riparian rights of Connecticut and of all individual citizens regardless of the effect of the diversion or of its size with relation to the whole stream flow of the Connecticut River at the Massachusetts-Connecticut boundary and, furthermore, that the proposed diversion would be, in effect, an attempt by Massachusetts to take by eminent domain property rights in Connecticut.

In reply, Massachusetts contended that her answer to the original bill, "either by the denial of allegations contained in the Connecticut bill or by affirmative allegation, sets up facts showing that the Massachusetts project will in fact result in the diversion of only a small portion of the waters which flow in the Connecticut River across the Connecticut-Massachusetts boundary," and that this diversion would have no adverse effect upon the navigable capacity of the Connecticut River; would constitute only a reasonable use of the interstate stream; would in fact have no tendency to injure health, welfare, safety, or property of the state of Connecticut or its citizens; and would benefit Connecticut by stabilizing stream flow, through the storage of flood waters some of which would be released in dry summer months; and that these facts revealed the project to be within her sovereign power because the proposed diversion would constitute "a reasonable use of the waters of the Connecticut River watershed, not only under the principle of equitable division between States of the benefit to be derived from an interstate stream but also under the principles of riparian law in force in the two States."

(c) That the following allegations of the answer were immaterial, *viz.*: those setting up the existing emergency in Boston; the benefit to Connecticut of a compensatory flow in summer months; the existence of an adequate remedy at law; and laches.

In reply to this Massachusetts contended "that these allegations not only show the reasonable nature of the diversion but also furnish a basis for the application of equitable defenses and for the denial of specific relief upon the equitable principle of comparative damage and necessity."

On January 20, 1930, following oral argument by the complainant, the Court denied the motions.

Connecticut's Reply to Massachusetts' Answer as Amended. Connecticut's reply, filed January 27, 1930, was brief but all-inclusive, and the second paragraph brought definitely into the case the question of necessity of going to the tributaries of the Connecticut River for an additional water supply for the Metropolitan District. This reply quoted in full is as follows:

1. The complainant denies all of the affirmative allegations of the defendant's answer as amended.

2. The complainant further says that there now exists in the Eastern part of the Commonwealth of Massachusetts a full and adequate supply of water susceptible of use for a domestic supply for the Metropolitan District and that there is no necessity now existing to divert waters from the watershed of the Connecticut River Valley to the Metropolitan District for such purpose.

Hearings before the Special Master. Charles W. Bunn, Esq. of St. Paul, Minnesota was appointed as Special Master on December 2, 1929, and was authorized to take and report to the Court the evidence together with his findings of fact, conclusions of law and recommendations for a decree. Hearings were held and evidence was taken in Boston, Mass. and in Hartford, Conn., from February 18 to March 21, 1930. The record covers 2 274 pages. On April 23 and 24, 1930, the case was argued before the Special Master in St. Paul.

Special Master's Report. The Special Master's Report, filed May 19, 1930, sustained the contentions of Massachusetts and recommended a decree dismissing the bill, with a provision for the protection of the owner of the potential water power at King's Island on the Connecticut River in the state of Connecticut.

Exceptions to the Special Master's Report. Connecticut filed, on October 6, 1930, seventy-five exceptions to the Report of the Special Master. Massachusetts filed none. Both submitted briefs and reply briefs in December, 1930, upon Connecticut's exceptions.

On January 5 and 6, 1931, the case was argued upon the exceptions before the Court.

Decision and Decree. Mr. Justice Butler delivered the opinion of the Court on February 24, 1931. Connecticut's Bill of Complaint was "dismissed without prejudice to her right to maintain a suit against Massachusetts whenever it shall appear that substantial interests of Connecticut

are being injured through a material increase of the amount of the waters of the Ware and Swift rivers diverted by or under the authority of Massachusetts over and above the quantity authorized by the Acts of 1926 and 1927 as heretofore limited by the War Department."

The Evidence Before the Special Master.

At the beginning of the hearings, counsel for Connecticut endeavored to show that the diversions from the Ware and Swift rivers, as authorized by Chapter 375 of the Acts of 1926 and Chapter 321 of the Acts of 1927, are but the preliminary steps of a much larger project for the ultimate diversion of the water of other tributaries of the Connecticut River in Massachusetts, the diversion from such tributaries having been mentioned as possibilities in the distant future in the earlier legislative reports, previously referred to in this paper. Exhibits were introduced by Connecticut to show the effect upon the flow and the height of water in the Connecticut River of assumed diversions from the Millers, Quaboag, Deerfield and Westfield rivers in addition to those authorized from the Ware and Swift. Total diversion thus assumed amounted to nearly five times the authorized Ware and Swift diversions. Counsel for Massachusetts objected to consideration of any diversions other than those authorized by present legislation and, furthermore, to the consideration of evidence which did not take into account the effect of the restrictions upon diversion placed by the War Department.

The case naturally divided itself into two parts, (1) Connecticut's original bill of complaint and the damages set forth in it and, (2) the question of necessity for the Boston Metropolitan District to go to the tributaries of the Connecticut River for its water supply.

The evidence may be classified and discussed under the following headings:

I. Stream Flow.
II. Navigation.
III. Power.
IV. Agriculture.
V. Pollution.
VI. Fish Life.
VII. Water Supplies Available for Development and Demand for Water in Eastern Massachusetts.

I. Stream Flow. Since all possible damages to be caused to Connecticut by the proposed diversions depend upon stream flow, this evidence was submitted early in the hearings. The records of flow published by the United States Geological Survey and other fundamental data were accepted by both sides. The following facts were also agreed upon:

Total watershed of Connecticut River at mouth, 11 300 sq. miles.

Watershed of Connecticut River tributary to river at Massachusetts-Connecticut state line, 9 722 sq. miles.

Watershed of Connecticut River in Connecticut, 1 385 sq. miles.

Total watershed of Ware River, 221 sq. miles.

Watershed of Ware River at the point of diversion, 98 sq. miles.

Total watershed of Swift River, 213 sq. miles.

Watershed of Swift River at point of diversion, 186 sq. miles.

Watershed of Swift River at Bondsville, 195 sq. miles.

The total watershed of the two rivers subject to partial diversion is 2.93 per cent. of the total watershed of the Connecticut River above the state line. (Ware River 1.01 per cent.; Swift River 1.92 per cent.)

The mean annual discharge of the Connecticut River at the Massachusetts-Connecticut state line is 17 000 c.f.s.

The average net diversion from both the Ware and Swift rivers under the War Department's restrictions is 2 per cent. of the mean annual discharge of the Connecticut River at the Massachusetts-Connecticut state line.

The total amount of stored water, to be released from the Swift River Reservoir under the War Department restrictions, which would actually increase the flow that would otherwise exist in the Connecticut River, would average about 146 million cu. ft. per year, or .03 per cent. of the average annual flow of the Connecticut River at the state line.

II. Navigation. The Connecticut River is considered navigable from Long Island Sound to Holyoke, and there is a War Department project for maintaining a channel 12 ft. deep at mean low water and 100 ft. wide up to Hartford. Tide water extends a few miles above Hartford to Windsor Locks where there are locks and a canal for enabling small vessels of low draft to pass between tide water and the pool formed by the dam of the Windsor Locks power development. This pool extends upstream to Holyoke. Water travel between Hartford and Holyoke, however, is seasonal and almost entirely by small pleasure boats. The commerce below Hartford is largely interstate and of considerable volume, consisting mostly of coal and petroleum products.

In substance, Connecticut averred that the entire normal flow of the Connecticut River and its tributaries is necessary to maintain the navigability of the river and to keep it free from sand bars and that any diminution in the flow would cause the stream to be sluggish, so that debris would collect on the bars.

Although the Government project is for a 12-ft. channel, it was testified that the usual minimum depth over bars was 10½ to 11 ft. because, after dredging is completed each year, the bars again fill in. Dredging is done after the spring freshets have subsided because of the fact that floods and freshets fill up the bars.

The effect of diversions upon navigable depths, as testified to for Connecticut, indicated that on the average when low water in the river at Hartford is one foot below mean low water, the water which would be released from the Swift River Reservoir under the requirement of the War

Department would increase the navigable depth about $\frac{1}{4}$ in., and that at mean low water, the corresponding increase would be about $\frac{1}{3}$ in.; with low water at one to two feet above mean low water the diversion would result in a lowering of $\frac{1}{2}$ in.; at 3 ft. of $\frac{3}{4}$ in., and so on up to a lowering of 3 in. when the river stands 10 ft. above mean low water. (Tidal action at Hartford ceases when the river rises 4 or 5 ft. above mean low water.) Also that the maximum lowering of flood heights might amount to about 6 in.

These figures were in substantial accord with the testimony offered for Massachusetts and were not questioned.

Testimony for Massachusetts that 94 per cent. of the total diversion permitted is taken out when low water at Hartford is 1.5 ft. above mean low water or 13.5 ft. above the channel bottom of the Government navigation project, and that if at any time under average conditions low water is lower than 0.1 ft. above mean low tide, which corresponds to 12.1 ft. above project channel bottom, the interests of navigation are safeguarded by the release of stored waters from the Swift River Reservoir under the requirements of the War Department, so that the navigable depth is generally slightly increased in times of lowest flow was not questioned.

III. Power. There is now one water power development on the Connecticut River in Connecticut. This development which has a total capacity of 4 000 h.p., composed of a considerable number of water-wheel installations in industrial plants at Windsor Locks, is owned by a public service corporation. A redevelopment to 50 000 h.p. is a possibility and has been approved by the Federal Power Commission.

No evidence was introduced to show that the proposed diversions would in any way damage the present development, but testimony for Connecticut showed an estimated annual loss in productive results to the proposed redevelopment of $7 920. Testimony for Massachusetts, on the other hand, showed that the additional water released from storage in the Swift River Reservoir during dry periods under the requirements of the War Department would be of such value as to permit a saving in capital expenditures for auxiliary steam plant amounting to $80 000.

The Special Master capitalized at 5 per cent. the yearly damage of $7 920 claimed by Connecticut, called it $160 000 and deducted from it $80 000, the saving in capital investment estimated by Massachusetts. He stated: "Therefore it appears that if this water power is developed to the extent of 50 000 h.p., the Massachusetts diversion of Ware and Swift waters will cause an injury to the power of $80 000."

IV. Agriculture. In her bill of complaint, Connecticut claimed that the proposed diversions will diminish the area of land flooded by the annual spring freshets and fertilized by sediment deposited on them and that the diversions will thus diminish the value of the land flooded for farming purposes generally and especially for the purpose of raising tobacco, hay and vegetables.

The testimony on the subject of agriculture occupies some 120 pages of the record and is summed up as follows in the report of the Special Master:

> It needs no testimony to prove that floods and inundations frequently cause damage. The Mayor of Hartford in this case showed dikes built at considerable expense in Hartford to fend off Connecticut River floods. The benefit from inundation of the 9 500 acres of hay land is exceptional. The amount of injury to the hay crop likely to result from the Swift and Ware diversion was not proven, — probably is not capable of proof — and was left to conjecture. How much hay land would fail to be submerged because of the diversion is quite uncertain. The land owners who testified showed that the hay lands were not of uniform elevation; that sometimes small areas are not submerged resulting in a diminished crop.
>
> The height of floods will be lessened from 1 to 6 inches by the proposed diversion. It seems certain that small pieces of hay land here and there in some years would fail, because of the diversion, to receive flood waters, which they would have gotten without it. But there is no attempt to show to what extent this would be true and it is impossible to determine from the evidence.
>
> The lessening of spring floods will have its advantage and disadvantages. It will lessen some damages and increase others. On the whole I think the damage to the hay land is not shown to be of "serious magnitude"; and that such damage, far from being "established by clear and convincing evidence," is shown by no evidence making it possible of computation or proving that it is large.

V. Pollution. The Connecticut bill made allegations with regard to pollution which are summarized in the Massachusetts brief before the Special Master in the following words:

> 1. It is set forth that certain cities and towns, factories and riparian owners in Massachusetts, discharge sewage and waste matter into the Connecticut River. The bill avers that this necessitates that the natural flow of the river, including flood flows, should remain undiminished and unimpeded. Any interference with, or diminution of this flow, it is said, will seriously affect the health of the citizens of Connecticut, cause great sickness and suffering, make possible disease and epidemics and cause irreparable damage to the state of Connecticut and the citizens thereof.
>
> 2. The bill then alleges that Massachusetts has made extensive plans to take not only waters of the Ware, Swift and Millers rivers, but also waters of the Deerfield, Westfield and Quaboag rivers, which takings will so reduce the flow of the Connecticut River as to affect the health of the citizens of Connecticut.
>
> 3. It is then set forth that, in addition to the diversions from the above-named six rivers, Massachusetts intends to divert other waters which will be turned into the Connecticut River in a polluted condition.
>
> 4. The bill at various places avers that any appreciable interference with the normal flow of the stream, and especially the removing of the beneficial effects of the flood waters at certain times in the year, will mean serious concern to the health and welfare of the thousands of inhabitants of the state of Connecticut who live along the banks of the stream, and particularly in the cities of Hartford and Middletown.

Not much appeared in the evidence on the pollution phase of the case relative to diversions other than from the Ware and the Swift rivers.

In preparation for this phase of the case, Massachusetts, during the summer of 1928, established a chemical and bacteriological laboratory in Springfield, and during the period from September, 1928 to March, 1930,

when the hearings were being held, collected and analyzed more than four thousand samples of water from the Connecticut River and its tributaries at fifteen sampling stations. Connecticut also conducted similar examinations during the period, from June 17 to November 18, 1928, and from July 8 to September 16, 1929. Without going into a detailed discussion of the evidence submitted by both sides of the case, it may be stated that the results of the analyses made by Connecticut and those made by Massachusetts were not materially different, and that in general the Connecticut River, even in times of such extremely low flows as existed during the summer and fall of 1929, is not in a seriously polluted condition. The average oxygen saturation at the Massachusetts-Connecticut line during the period from July 8 to September 16, 1929, was found by Connecticut to be 54 per cent. The pollution studies by Massachusetts, furthermore, showed that the stream at the state line at all times had an ample reserve capacity to care for additional pollution over and above that which it contained and to carry that pollution to the sea without the production of a resulting nuisance. It was further shown that this capacity to take on and satisfactorily dispose of additional pollution rapidly increased below the state line, due in part to re-aëration and in part to inflow of relatively pure water from tributary streams, until at a point six miles below Hartford its capacity to receive and dispose of additional pollution had materially increased in spite of the fact that it had received the untreated sewage from the city of Hartford in the stretch of river intervening below the state line.

The case was not of course directly concerned with the existing conditions in the river, but more particularly with what might be the effect upon those conditions of the diversions proposed by Massachusetts. In this connection it is interesting to note that the experts of both sides of the case were agreed that the effect of the proposed diversions upon the quality of the water of the Connecticut River at the Massachusetts-Connecticut state line would be so small as not to be detectable by analysis and that any damage caused by the diversions or advantage resulting from the releases required by the War Department would be purely theoretical.

The Special Master in his report concluded:

> I think the plaintiff has failed to prove that the proposed diversion would perceptibly increase Connecticut River pollution, and consequently that there is no satisfactory proof of material pollution damage to the Connecticut to result from installing and operating the proposed Ware and Swift works.

VI. Fish Life. The evidence showed that, in the spring, shad run up the Connecticut River and its lower tributaries to spawn. It was testified for Connecticut that a reduction in flood flow would be harmful to fish life. Statistics and a graph showing the annual shad catch and also the height of the highest May flood in practically each year from 1872 were presented. The Special Master, however, found that these failed to prove that shad catches follow high May floods and stated that the charts led to the infer-

ence that the variation in shad catch was due largely to elements other than to high floods. He found, furthermore, "that the lowering of flood water resulting from proposed diversions is not shown to be materially injurious to the shad run."

VII. Water Supplies Available for Development and Demand for Water in Eastern Massachusetts. Connecticut claimed, in an amendment to its original bill, that there is no necessity to divert waters from the watershed of the Connecticut River and that there is an ample supply of water in the eastern part of the Commonwealth. In support of this allegation Connecticut introduced two plans for additional supply for the Metropolitan District.

One of these plans, which became known as the Fifteen Watershed Plan, proposed the development of nine small watersheds (totaling 58.8 sq. miles) on the drainage area of the Assabet River; the use, with filtration, of additional drainage areas, at present developed but not used, on the south branch of the Sudbury River; the pumping of water from the lower Sudbury River into an enlarged Hobbs Brook reservoir; the taking of water from the Shawsheen River and from the Ipswich River and pumping it to a large reservoir to be constructed on the Ipswich River from which, after treatment by long storage and filtration, it would be pumped to Spot Pond, one of the existing distribution reservoirs of the Metropolitan District.

The other plan consisted of taking 200 m.g.d. from the Merrimack River at Tyngs's Island (not far below the New Hampshire line) and pumping it to a large reservoir, previously referred to, on the Ipswich River watershed, from where, after long storage and filtration, it would be pumped to Spot Pond.

It was agreed by both parties that the Boston Metropolitan District was in need of an additional water supply and, furthermore, that, if the proposed Ware and Swift river supplies were to be denied, all the population in the northeastern part of the state must divide up the available supplies. Connecticut endeavored to show that adequate and suitable supplies are available in northeastern Massachusetts for that entire region including the Metropolitan District, and Massachusetts endeavored to demonstrate the unsuitability and inadequacy of these sources.

The Fifteen Watershed Plan as proposed by Connecticut would make available for northeastern Massachusetts additional supplies amounting to 179 m.g.d., of which 157 m.g.d. would be available to the Metropolitan District. This supply would admittedly be inadequate to meet the estimated requirements of the district in 1970, and before that time, it would be necessary to seek an additional supply either from the Merrimack River or from elsewhere than northeastern Massachusetts. Massachusetts attacked the plan on the grounds of inadequate quantity and undesirable quality and further claimed that the downstream communities on the wat-

ersheds affected require all of the available water for their various water needs including those of power, process water and dilution of pollution; that the plan would not be acceptable to the people; that the diversion of water might be curtailed by the War Department because of possible interference with navigation in the Merrimack River to which most of the 15 watersheds are tributary; and that the cost would be excessive.

The Merrimack River plan was objected to on various grounds such as interference with navigation on the lower Merrimack, pollution from out of state sources, the use of water from a highly polluted source, and damage to large vested interests.

The question of lack of acceptability to the people was stressed, and Massachusetts presented witnesses who testified to the intense opposition which had been aroused in the Ipswich Valley and in the valley of the Concord River and its tributaries, the Assabet and Sudbury rivers, by the proposal in 1925 to develop a water supply for the Metropolitan District from many of the watersheds involved in the Fifteen Watershed Plan.

Some of the conclusions of the Special Master in these matters are as follows:

> The first fact, and I think it quite important, is that the people of Massachusetts have decided against the eastern water supplies by passing the Ware and Swift legislation. These acts were the result of long-continued and careful study commencing in 1895. In that year there was a report, House Document (1895) No. 500, by the Massachusetts State Board of Health. As a result of this report the present Wachusett Reservoir, in which are stored the waters of the upper Nashua River was adopted. A second report was made in 1922, House Document No. 1550, a Report of Joint Board of Water Supply Needs and Resources. This report embodied the recommendations of the Massachusetts State Department of Health and the Metropolitan District Commission jointly, as to the appropriate method of extending the Boston Metropolitan District water supply. The report recommended extending a tunnel westwardly from the Wachusett Reservoir to the Ware, thence further west to the Swift where a reservoir was to be built in which to store waters drawn from these streams. This report was not acted upon by the legislature at once and another commission known as the Gow-Hazen Commission examined the situation and reported in favor of taking water from the Ware River together with certain eastern Massachusetts sources (including the Assabet, Ipswich and Sudbury Rivers). This report raised objections from the Ipswich Valley, from Concord, and from towns on the Assabet. Finally the legislature definitely rejected the eastern supplies including the Merrimack and passed the acts of 1926 and 1927 for taking water from the Ware and Swift. I think these investigations and the legislative acts show a public sentiment against the eastern water supplies and make a *prima facie* case that these supplies are inadvisable, either because inadequate or unfit. . . . Our governments in the long run are controlled by public opinion. And while an expert on water, acting in a strictly professional capacity, may say that he will disregard public opinion, municipal and other governments cannot take that stand. The courts it seems to me cannot close their eyes to the necessities imposed by public opinion on governments. . . . I find from the evidence on this subject (*i.e.* the Fifteen Watershed Plan) that whilst Boston might make available a considerable amount of water from the sources referred to and in the manner referred to, or in some other manner, most of the water is of a quality much inferior to the Ware and Swift and that the project is inferior from an engineering standpoint to the reservoir and tunnel which the Ware-Swift devel-

opment involves. It is also I think certain that whatever water might be realized from the sources in question would be in the first place an inadequate supply and fill only a part of the requirements, and would be in the second place a supply largely of uncertain duration which in whole or in part might have to be thrown away in the future. . . . I find the taking from the Merrimack ought not to be imposed upon the Boston District. Because first the water is a polluted water and Massachusetts has not adequate control of the pollution or adequate remedy to cure it; that the water is of quality much inferior to the Ware and Swift and the proposed project inferior from an engineering standpoint to the reservoir and tunnel which the Ware and Swift development involves. I find that the two reservoir sites, Foster and Martin's pond and Ipswich site are much inferior to the dam site at the Swift. The bottoms of these ponds are partly marsh or peat and some of the inclosing walls are of great length. I think there is danger that the proposed abstraction will work an important and undetermined damage to present and future factories both at Lowell and Lawrence. I find that the proposed takeout is of such a large part of the river flow that a substantial reduction of it by the Secretary of War is probable. I find generally in respect both of the Merrimack diversion and the Fifteen Watershed Plan that the waters for the most part are polluted and require substantial and extensive treatment by some or all of the modern methods and that in many ways it is most advantageous to obtain a source of pure supply wherever reasonably possible.

The Recommendation of the Special Master.

The Special Master concludes his report as follows:

(a) I have not gone into the comparative cost of the various projects because I think it is immaterial. There is no such wide divergence in cost as to make it a determining factor.

(b) I have disregarded entirely, because it seems to be immaterial, a large amount of testimony on another line. It was contended by Connecticut that the Ware and Swift scheme was simply an entering wedge to the drafting of added waters in the future from the Connecticut Valley; and proof was offered of previous proposals in Massachusetts reports and documents to take water from the Millers River and other Connecticut tributaries. It was sought to prove that the tunnel from Wachusett to the Ware and beyond to the Swift was larger than necessary to carry the 191 000 000 gallons a day and that this must be for the purpose of taking added water in the future. I disregard such evidence altogether as it seems to me immaterial. The Massachusetts legislation confines itself to taking certain waters from the Ware and Swift. The Secretary of War has imposed additional limitations. Massachusetts says she intends to divert no more water than the Secretary of War permits and in every way to follow the conditions he imposes. It is true that counsel in this case cannot control the future action of Massachusetts. But it is sufficient for this case to say that injunction should not issue against something merely feared at some indefinite time in the future. Injunction issues to stop present injuries or those presently threatened. The judgment in this case, if it goes in favor of Massachusetts, should settle her right to take only so much water and in such manner and at such times as the Secretary of War permits. It will in no way bar or diminish the right of Connecticut to proceed against the taking of additional future water. For this reason I disagree with the suggestion advanced by Connecticut on the hearing, that she is entitled at least to an injunction restraining Massachusetts from taking any more water than the Secretary of War has authorized. As there is no threat on the part of Massachusetts to do that, such an injunction does not seem to me proper.

(c) It may be suggested that Massachusetts has lost rights which she otherwise might have had by having herself allowed her eastern waters to be polluted; and that she cannot profit by a necessity for Ware-Swift water which she has created. This is not the

case of a plaintiff coming into equity where he must come with clean hands. But perhaps the principle of coming in with clean hands may sometimes be applicable to a defendant. If Massachusetts were grossly at fault in polluting her eastern waters so that they were unfit for use and that was the only thing which created the need for Ware-Swift waters, I should feel she might be held to pay the price of her own wrongdoing.

However, her practice has not been different from that of Connecticut and other New England states and it is a matter of notoriety that it is not different from the practice which has prevailed on other rivers and in other parts of our country. The pollution of our country's rivers makes a pitiable record. I think Massachusetts should not be penalized in this fashion for following a practice which has been almost or quite universal in the United States. It is to be noted too that the more important supply, the Merrimack (the other supply being at best insufficient), is polluted in major part by New Hampshire population and factories.

(d) It seems to me the decree should be; dismissing the bill with a provision that if (say within ten years) a dam at or near King's Island on the Connecticut is built to develop substantially 50 000 horse power, Massachusetts pay the owners of such dam and power the sum of $80 000.

The Opinion and Decree.

The Opinion. The opinion of the Court, delivered by Mr. Justice Butler on February 24, 1931, after reviewing the facts of the case and the report of the Special Master, concludes as follows:

It is very clear that, under earlier decisions here, the strict rules for which Connecticut contends are not necessarily controlling in this case. There is nothing in the Master's findings of fact to justify an inference that any real or substantial injury or damage will presently result to Connecticut from the diversions by Massachusetts authorized by the Acts of 1926 and 1927 as limited and defined by the Secretary of War. No discussion is required as to the effect of the proposed diversion upon the navigability of the river, agriculture, fish life or pollution in Connecticut.

The proposed taking of the waters of the Swift and Ware will not affect the present dam, works or production of power at King's Island. While the owning company has secured authority to build the higher dam, it has not resolved so to do. It is not found and there is nothing to show that it intends to construct any dam or works of a kind or capacity that, if now in use, would be injuriously affected by such diversion. At most there is a mere possibility that at some undisclosed time the owner, were it not for the diversion, might construct additional works capable of using all of the flow of the river including the waters proposed to be taken by Massachusetts. Injunction will not issue in the absence of actual or presently threatened interference. The facts disclose no basis for relief in respect of that property. *New York* v. *Illinois*, 274 U. S. 488. *New Jersey* v. *Sargent*, 269 U. S. 328, 331, 338.

Drinking and other domestic purposes are the highest uses of water. An ample supply of wholesome water is essential. Massachusetts, after elaborate research, decided to take the waters of the Ware and Swift rather than to rely on the sources in the eastern part of the Commonwealth where all are or are liable to become polluted. We need not advert to other considerations, disclosed by the evidence and findings, to show that the proposed use of the waters of the Ware and Swift should not be enjoined.

Connecticut maintains that the presently proposed diversion will not be adequate for the future needs of the Boston district and that the size and character of the works as well as legislative reports and other circumstances disclose an intention on the part of Massachusetts, when the need shall arise, to draw from other rivers — Millers, Deerfield, Quaboag and Westfield — tributary to the Connecticut and insists that the decree should restrain Massachusetts forever from increasing its diversion to an amount in

excess of what the Secretary of War has already indicated would cause no damage to the navigation of the Connecticut.

The scope of the project is that shown by the Acts as limited by the determination of the War Department. It involves no diversion from streams other than the Ware and Swift. Massachusetts declares that she intends to and must obey these findings of the War Department. Her statements before the Master and here clearly negative any threat, intention or purpose to make any diversion of water in excess of that specified or otherwise than as set forth in the determinations of the War Department. Injunction issues to prevent existing or presently threatened injuries. One will not be granted against something merely feared or liable to occur at some indefinite time in the future.

New York v. *Illinois*, *supra*. *New Jersey* v. *Sargent*, *supra*.

Connecticut's Bill of Complaint will be dismissed without prejudice to her right to maintain a suit against Massachusetts whenever it shall appear that substantial interests of Connecticut are being injured through a material increase of amount of the waters of the Ware and Swift diverted by or under the authority of Massachusetts over and above the quantities authorized by the Acts of 1926 and 1927 as heretofore limited by the War Department. Each party will pay its own costs, one-half of the expenses incurred by the Special Master and one-half the amount to be fixed by the Court as his compensation.

Counsel for Massachusetts will prepare a form of decree in consonance with this decision and furnish a copy to counsel for Connecticut within fifteen days; and, within ten days after such submission, the draft decree together with suggestions in behalf of Connecticut, if any, will be submitted to the Court.

The Decree. The decree in full is as follows:

This cause came on to be heard upon the pleadings, evidence, and the exceptions filed by the complainant to the Report of the Special Master, and was argued by counsel. The Court now being fully advised in the premises and for the purpose of carrying into effect the conclusions set forth in the opinion of this Court announced February 24, 1931,

It is now here ORDERED, ADJUDGED AND DECREED as follows:

First that the Bill of Complaint herein be and the same hereby is, dismissed without prejudice to the right of the complainant to maintain a further suit against the defendant at any time in the future when it shall appear that substantial interests of the state of Connecticut are in fact being injured, or are about to be injured, through a material increase of the amount of the waters of the Ware River and of the Swift River diverted or to be diverted by, or under the authority of, the Commonwealth of Massachusetts, over and above the quantities authorized to be diverted by the provisions of Chapter 375 of the Acts of 1926 and by Chapter 321 of the Acts of 1927 of the General Court of the Commonwealth of Massachusetts, as said quantities have heretofore been limited by two certain findings of the Secretary of War of the United States, acting upon the recommendation of the Chief of Engineers of the United States Army, dated respectively March 14, 1929, and May 11, 1929, and more fully set out in Appendix B and Appendix C of the Reprint of the Answer of the Defendant herein, filed January 20, 1930, and of Record in this cause.

Second that each party shall pay its own costs, together with one-half of the expenses incurred by the Special Master, Charles W. Bunn, Esquire, of St. Paul, Minnesota, and one-half of the amount fixed by the Court as the compensation of the Special Master.

The writer is pleased to acknowledge his indebtedness to Walton H. Sears, a member of this Association and Mechanical Engineer, Metropolitan District Water Supply Commission, who has assisted in the preparation of this paper.

DISCUSSION.

Discussion by Weston E. Fuller.*

The author's paper covers the case of *Connecticut* v. *Massachusetts* so clearly and concisely that there is little to be discussed in connection with that case. There remains, however, the very interesting matter of the diversion of interstate rivers. As the case of *New Jersey* v. *New York* has also been decided by the Supreme Court, these two cases afford a fairly clear indication of how the Supreme Court regards this subject. As was stated by Justice Holmes in the case of *New Jersey* v. *New York* "The different traditions and practices in different parts of the country may lead to varying results but the effort always is to secure an equitable apportionment without quibbling over formulas." That such was the view of the Court was made clear in cases in the West, and the only question not settled related to the difference in the "water laws" of the West as compared with those of the East. Indeed, the Supreme Court merely followed the custom of the states where diversion of water for water supply purposes from one watershed to another has long been the common practice. Instances of such diversion in all the states involved in these recent controversies are easily cited. Why the common law should apply to interstate streams and not to streams lying wholly within a state seems difficult to understand. That the principle of equitable apportionment for the entire country is definitely laid down, can no longer be questioned.

The weight given to damage suffered by the diversion can be measured to some extent by these recent decisions. It will be noted that where a single power plant was damaged and where the damage could be ascertained, it was not considered as a reason for limiting or prohibiting the diversion. On the other hand, in the case of *New Jersey* v. *New York*, damage to the river for recreational purposes and for the oyster industry were considered as grounds for limiting the diversion. The essential difference seems to be that these last mentioned damages affected a considerable number of people, were more general in effect and of necessity not easily ascertained for purposes of compensation. It would seem, therefore, that where the damage affects the general public, it is considered of more importance than where it affects only a few individuals and can be easily compensated for. It may also be mentioned that such damages are by far the most difficult to combat. The testimony is largely by those who are directly interested and not in a position to understand the full conditions of the diversion and the benefit from the release of water during the dryer portions of the year.

These cases, together with earlier decisions, bring out clearly that damages, to be given any consideration, must be to existing property or to that which in all probability will be presently constructed. Where it is necessary that additional consents of states or of the United States Govern-

*Of Fuller and Everett, New York, N. Y.

ment are involved, apparently, they are given no weight. This is indicated strongly in the case of *New Jersey* v. *New York*, where water power developments were not authorized and could only be obtained by consents of New York, Pennsylvania and the Congress of the United States. It is true that the Master also stated that such a development probably would not pay, but the indications are strong that even if it were a profitable undertaking, the lack of rights would have eliminated the water power element. This is also indicated in an earlier case — *New York* v. *Illinois* — in which the diversion due to the Chicago Drainage Canal was objected to by New York on the grounds of injury to the water power on the St. Lawrence River. The Supreme Court ruled, however, that such power needed the consent of Canada as well as the United States Government and decided against New York.

These cases also seem to have definitely settled that a city is entitled to secure the best available supply; that it is not compelled to accept a lower standard of quality merely because such can be obtained within the limits of the state, nor that, because other cities are compelled by conditions to accept inferior water which must be purified and treated, more fortunately situated cities must do likewise.

It seems that these decisions also indicate that where large diversion is to be made, the water to be diverted must be that which comes during periods of large flow, and that some compensation during dry periods may be required.

It is perhaps needless to add that interference with navigation as outlined by the War Department is a consideration which apparently must be met.

The amount of diversion in the case of *New Jersey* v. *New York* amounted to some 17.8 per cent. of the total area above the New Jersey state line while the total diversion in the case of *Connecticut* v. *Massachusetts* was only some 2 per cent. of the area above the Connecticut line. It is obvious that the effects of diversion in the New York case were much greater than in the Massachusetts case. The results of the decisions were that while the War Department ruling cut the Massachusetts diversion slightly, the New York diversion was cut to 73 per cent. of that asked for. In addition to this cut in quantity, certain other requirements were made upon New York. These were that the sewage and industrial wastes of Port Jervis should be purified and that larger quantities of water should be released when the flow in the river fell below 0.50 c.f.s. per sq. mile at either Port Jervis or Trenton. This placed upon New York the burden of providing sufficient storage to control the river to this quantity with a limitation that not more than 0.66 c.f.s. per sq. mile of watershed diverted be released. It means that in the earlier years, when New York only is diverting water, more storage is required than will be the case later when Pennsylvania and New Jersey likewise divert water. Fortunately, a large power development in the Wallenpaupack has been already constructed. If it is used as a peak

load plant for dry weather use, it will greatly aid in the release of water at such periods. It seems rather unfair that New York should be compelled to regulate the river at Trenton which is in effect asking New York to make up the deficiency caused by low flows in Pennsylvania. It would seem that if New York compensated for the low flows at the state line it had performed its full duty. However, with the Wallenpaupack release of stored water, the added storage may not be very great.

In general, the decisions in both the case of *Connecticut* v. *Massachusetts* and that of *New Jersey* v. *New York* may be regarded as victories for water works and a recognition that water supplies for our cities are of great importance and that such use is more important to the general welfare of the country than the use of water for other purposes.

Discussion by James F. Sanborn.*

The principles announced by the Supreme Court governing the fair and reasonable allotment of waters between states are so new as to be little familiar to most engineers. Between cities and districts within a state conflicts of interest sometimes arise over the diversion of water supplies, but these are readily adjusted; it is only recently that we have even considered the possibility of such diversions between states as are now assured. Within states, means have long been provided to apportion available water resources, but until now, when interstate waters are to be used, no certain method had been found for serving public interests applying for great diversions of flood waters and the release of compensating waters in the dry months of the year.

The numerous legal points which have come up in the trials of the Massachusetts and New York cases have been thoroughly presented. In the complaint of the state of Connecticut against the Commonwealth of Massachusetts, the Master was repeatedly assured by the Connecticut side that this diversion marks only the start of a wholesale demand for water from tributaries of the Connecticut, — that Miller's River would be next, then other Massachusetts branches. The Connecticut lawyers spoke of the present undertaking as the "entering wedge." But the Court ruled that the present case only was to be considered, and found that the waters (spoken of by one of the New York attorneys in the Delaware case as "wild waters") could properly be conserved and used for the benefit of the people of the Boston Metropolitan District.

In addition to the legal principles expounded by the Court, the testimony presented by experts on both sides in the Massachusetts and Connecticut case sums up well many current theories of public water supply practice. There was some discussion of what may be expected in the distant future and of the mutual benefit to be gained by arrangement between municipal consumers and large power companies for the supply of water

*Of Sanborn and Bogert, New York, N. Y.

for domestic and industrial use from great storage reservoirs created for the production of power.

Mr. Goodnough testified that in the future large power developments on the Connecticut or Merrimack may perhaps combine with cities and water districts to supply their needs from large power storage. He cited the fact that this is being done now at Springfield, which city has combined with a power company to build a dam and storage reservoir which neither could afford to build alone.

About ten years ago, the writer made a report on the project advanced by a large power company to supply the city of Baltimore with water through a thirty-mile tunnel from the Susquehanna River at McCalls Ferry, pumping with off-peak power; the supply would have been abundant and would have solved all questions of water shortage, but the city preferred to develop a supply from other sources.

A great hydro-electric plan has long been considered for the development of Adirondack power. The construction of the Sacandaga reservoir for the regulation of the Hudson is the first in a long list of storage plans for conserving the waters of that river. It seems likely that in due course, but perhaps far in the future, New York City will be able to secure a great supply from such storage. Similar great power developments on the Delaware have been studied, and at some time perhaps these may be developed, making available large resources of water for municipal water supply purposes.

It appears certain that power companies will in the future go into the water supply business on a large scale, to finance, construct and operate more cheaply than is possible by public ownership. Such private service would in many cases release money for other needed public improvements and greatly reduce the tax burden, while assuring a dependable supply of water.

Discussion by X. Henry Goodnough.*

The two very important cases, — *New Jersey* v. *New York*, and *Connecticut* v. *Massachusetts*, — show clearly the present attitude of the Supreme Court of the United States in the matter of the diversion of water of interstate streams from one watershed to another for public water supply purposes.

In the case of *Connecticut* v. *Massachusetts* the Special Master found that a supply of water could be obtained from the Merrimack River and from other sources, chiefly 15 small watersheds in eastern Massachusetts, which by treatment by modern methods could be used for water supply purposes, but that the water would be a polluted water of a quality much inferior to the Ware and Swift rivers. It was, of course, admitted by both sides that the water to be obtained from the Swift and Ware rivers was

*Consulting Engineer, Boston, Mass.

most excellent in quality. This conclusion was reached by all the engineers who had examined these sources and Mr. Allen Hazen remarked in his report concerning them, especially the Swift River, "that it was hard to imagine more favorable conditions."

The Special Master in his report to the Court stated that there was no such wide divergence in cost between the two plans as to make cost a determining factor in the case, and he evidently discarded it entirely. Thus the question came to be a choice between practically compelling the Metropolitan District to use a polluted water supply or approving the diversion of unpolluted water from an interstate stream to an amount which would not affect materially the rights of the inhabitants of the other state.

A most important consideration in deciding this question was the public opinion of the state which was to use the water. In this matter the Court deemed the conclusion reached by the Massachusetts legislature, after its very thorough consideration of the matter for a number of years, as conclusive with reference to the right of the community to have a pure water, even though it had to be taken from an interstate stream, in preference to a polluted water from within the state.

This decision will undoubtedly have a very marked influence, not only on the use of interstate streams under similar circumstances, but in the selection of sources of water supply in general for a long time in the future. With the rapid growth of population in many parts of the United States, and especially here in the Northeast, however, the question will arise, in fact it already has arisen, as to the practicability of one state securing water from within the limits of another state. Thus far, all such propositions in this part of the country have failed and are likely to continue to fail until some arrangement can be devised between the states which will secure an agreement for the diversion of water from one state to another on a basis which may be regarded as mutually advantageous.

When public water supplies were first introduced into the cities and larger towns, questions as to the adequacy of the supply and the economy of its introduction largely controlled the selection of the source of supply, and little was thought or known of the danger to health from drinking a polluted water. When attention was first directed to this danger, some forty or fifty years ago, methods of filtration and purification were devised which proved effective in reducing the danger from typhoid fever and other water-borne diseases. These methods have been further developed and brought to a high state of effectiveness, first by filtration and subsequently by the use of chemicals. More recently the great purifying effect of long storage has been more fully realized, and storage has been added as a further means of treatment of polluted water. But notwithstanding the efficiency of treatment methods, the demands of the public, in this part of the world at least, are steadily directed toward securing in the first place an

unpolluted water supply and then protecting and improving its quality in every reasonable way.

In consequence, it seems improbable that as cities continue to grow and demand increasing quantities of water, they will be restricted in their use of water or compelled to drink from polluted sources when ample supplies of unpolluted water in more remote districts are allowed to run to waste into the sea. There are many large streams in unpopulated or sparsely populated regions in the Northeast which can furnish plenty of water for some of the larger cities or districts but cannot be used because they cannot now be diverted across state lines.

Just how any such diversions may be brought about, it is difficult to say, and, in any case, any arrangements which may be made will no doubt vary materially according to circumstances. Possibly, some combination of power companies with a state or city may develop water supplies which can be used not only for the creation of power, but also for public water supply purposes to the material advantage of the states and other interests concerned, and in that way perhaps cross state lines. Such a combination has already been effected between a city and power company in this state, whereby the city obtains a large water supply and the power company a large accession of power by coöperation in the construction of works which neither party could have afforded to undertake solely for its own purposes. As the population of the states continues to grow, the time will inevitably come in some of them when they will have to go outside the state limits for an unpolluted water supply.

The recognition by the Court in this case of the importance of public opinion as a legitimate and most important factor in influencing legislation relating to water supplies will no doubt aid materially in the efforts of populous communities to secure unpolluted water supplies, either from an interstate stream where no serious injury may result to other interests, or form within the boundaries of another state, if a mutually satisfactory arrangement can be made.

Discussion by Earle B. Phelps* and Robert Spurr Weston.†

One of the principal points upon which the complainant state of Connecticut relied in its original Bill of Complaint, as the author has already indicated, was that the Connecticut River is grossly polluted by sewage and industrial wastes and that the contemplated diversion would reduce the capacity of the river to assimilate pollution, leading to conditions both offensive and detrimental to health. It was thought advisable by those in charge of the preparation of the Massachusetts case to carry out a scientific investigation of the present condition of pollution on the Connecticut River in such a manner that it would be possible, not only to answer this complaint

*Professor of Sanitary Science, Columbia University, New York, N. Y.
†Of Weston and Sampson, Boston, Mass.

in its present form and under the present-day conditions, but also to deal quantitatively with the questions of future growth in population, changes in the methods of sewage and waste disposal, and changes in the stream regimen.

This investigation was placed in the hands of the writers and was carried out through portions of the years 1928 and 1929. A well equipped laboratory was established in Springfield, and sample stations were established at various points along the Connecticut River from Northfield, Mass., to Rocky Hill just above Middletown, Conn., and also upon the principal tributaries near their mouths and at several points on the Ware, Swift, Quaboag and Chicopee rivers.

The work of the laboratory was directed by Mr. Walter H. Junkins, assisted by a sanitary engineer, a chemist, a laboratory assistant and a clerk. For special sampling operations, engineers were detailed from the engineering staff of the commission, and a boat with boatman was used during the open season for work on the river.

Rather complete routine chemical and bacteriological examinations were made for the purpose of obtaining incidental information and of tying into the existing records of the Massachusetts State Department of Health, but the chief reliance was placed on the newer methods of stream examination dealing with the dissolved oxygen and the biochemical oxygen demand of the stream and variations in these quantities geographically and with time and temperature. Since this study, as carried out, constitutes an excellent example of the practical usefulness of these newer methods, and since the data themselves constitute a record which may be useful for comparison with future investigations, it seems desirable to present at this time a brief survey of the principles involved and a recapitulation of the chief results.

The biochemical oxygen demand is essentially a measure made in the laboratory of the amount of oxygen which will be abstracted from the water under examination by its contained organic pollution under certain standard conditions of time and temperature. As actually determined and recorded, it measures the loss of oxygen during a period of five days' incubation at 20° C.

The time and temperature relations of this deoxidation or reducing reaction have been thoroughly investigated, and it is possible, by the application of a simple formula, to convert the standard values, as determined in the laboratory, into new values representing any desired time and temperature conditions. Since, in the particular case in hand, interest is centered in the time of passage from the point in question to the sea and in the existing temperature of the stream, these latter data were essential to a correct interpretation of the laboratory findings. That is, it is desired to know what will be the relative condition of the water after it leaves the sampling point and until it reaches some place of final disposal, as the sea.

A diagram was prepared under the direction of Mr. Walton H. Sears

of the Commission's staff showing the approximate mean time of passage of a given particle of water from station to station throughout the length of the river and tributaries at all stages of stream flow. A second diagram provided the time-temperature factor to be applied to the standard laboratory data, covering the time and temperature range under consideration.

With the help of these two diagrams it was possible to translate the laboratory findings directly into values which indicated the total amount of oxygen that would be abstracted from the stream by the pollution existing at the sampling station by the time that water had reached the sea. These data were simplified by one further factor, making them still more applicable and understandable. The oxygen-demand requirements of the domestic wastes from a sewered population have been accurately determined and found to be 0.22 lb. of oxygen per day per capita. This is an ultimate value and is reduced by formula for any given time and temperature. By an appropriate combination of this quantity and the quantity as measured at any station, it is possible to report the latter in the term "contributing population," thus giving an easily understandable quantitative expression for the sum total of all existing pollution, whether it has its source in domestic sewage, industrial wastes, or the natural organic pollution of the stream itself.

The biochemical oxygen-demand, as thus measured and recorded, represents the debit side of a ledger. The credit side is represented by two items, namely, the dissolved oxygen existing in the water at the time of sampling and the capabilities of the stream for absorbing oxygen from the atmosphere during passage to the sea, known as re-aëration. The first of these is a simple and direct chemical determination and by similar reference to the standard daily per capita value, likewise corrected for time and temperature, it too can be expressed in terms of population. The difference between this value and the value of the oxygen demand, both in terms of population, represents the population capacity of the stream at the point of sampling.

The population capacity constituted the basic reference mark of our interpretations of all the analytical data. In brief, it indicates the additional population which could sewer to the stream at the sampling station under the condition that (without further re-aëration) the oxygen of the stream would suffice to carry the total pollution from that point to the ocean.

It is important to note, first, that there is no implication that this additional load of pollution would be justified and, second, that the factor of re-aëration, if properly taken into account, would care for a further pollution load. The population capacity, therefore, is merely an arbitrary base line, like mean sea level, from which it is possible to measure existing or future conditions.

The chief interest in this computation lay in the stations along the main body of the Connecticut River and, for the legal requirements of the case, in the station lying at the Massachusetts-Connecticut state line.

The accompanying table summarizes the data at this station for fourteen months of continuous observations, computed as has just been indicated.

STREAM FLOW, TEMPERATURE, BIOCHEMICAL OXYGEN DEMAND, DISSOLVED OXYGEN AND RESULTANT POPULATION CAPACITY, IN THE CONNECTICUT RIVER AT THE MASSACHUSETTS-CONNECTICUT STATE LINE.

Year and Month.	Flow, c.f.s.	Temperature °C.	Population in Thousands Equivalent to		
			B.O.D.*	D.O.†	Population Capacity.
1928					
Oct.	9 900	14.0	703	4 690	3 987
Nov.	10 070	6.1	716	7 720	7 004
Dec.	9 300	1.3	827	9 490	8 603
1929					
Jan.	12 070	0.5	858	15 400	14 542
Feb.	8 860	1.0	1 008	8 880	7 872
Mar.	35 800	3.2	3 050	90 000	86 950
Apr.	49 050	7.6	2 440	147 200	144 760
May	38 500	12.4	1 915	58 300	56 385
June	9 880	23.0	562	2 930	2 368
July	6 440	23.3	481	1 130	649
Aug.	4 860	22.8	397	765	368
Sept.	4 890	19.9	434	850	416
Oct.	5 720	13.9	608	1 610	1 002
Nov.	7 730	8.2	852	4 340	3 488

*Biochemical oxygen-demand.
†Dissolved oxygen.

In the month of October, 1928, for example, the total pollution existing in the river at the state line was equivalent to that which would be derived directly from a contributing population of 703 000 people. There was sufficient oxygen already in the stream at the same time and place to meet the total requirements of a population of 4 690 000 during the time required for this water to pass to the sea and at the existing temperature of 14° C. The difference is a population capacity of 3 987 000 which, as previously indicated, measures the capacity of this water to receive and oxidize sewage without additional help from re-aëration. It will be noted, also, that the existing pollution measured in this way increases to high values during the spring floods, showing the combined effect of surface wash and of the cleaning out of the river pools. There is also a corresponding abnormally low value during the months of late summer undoubtedly related to sedimentation of material in these same pools.

Since the legal issue concerned the question of the effect of certain proposed diversions rather than the actual existing conditions, computations actually similar to the foregoing were made at the proposed points of diversion, from which it was readily possible to compute, in terms of population capacity, the effect of any stated diversion. This effect amounted in general to about 2 per cent. of the net population capacity at the state line. However, during the extreme low-water months, when an extra re-

lease of water is contemplated, the effect is to increase the net population capacity at the state line.

The small indicated population capacity during these same months, however, suggests, without further investigation, that the addition of the sewage of the Connecticut cities might seriously over-load the stream. It was necessary before this point could be quantitatively determined to make some estimate of the increased capacity of the stream to carry pollution because of its re-aëration and its actual increase in volume of discharge. This was done by another treatment of the data as fcllows.

Making a recomputation of the accompanying table in which the time factor was taken as the time required for the water to reach, not the sea, but the Rocky Hill station below Hartford, the amount of oxygen expected to be withdrawn from the water in that stretch was determined. To this must also be added the computed effect of the population sewering at Hartford and taken with an appropriate time factor at the Rocky Hill station. That is, the Hartford sewage must be considered as being delivered at Rocky Hill.

Actual comparisons of the dissolved oxygen at the two stations indicated an excess at the lower station rather than a deficiency. The additional quantity of oxygen thus found over the expected quantity represents the ability of the stream to obtain oxygen by re-aëration or through its tributaries. In this particular case no effort was made to separate these two sources of new oxygen, although an examination of the tributaries would have provided the necessary data for such separation, if required. In all cases, the net effect of the re-aëration in the stretch from the state line to Rocky Hill was greater than the total demands upon the stream by the pollution existing at the state line plus that discharged into the river at Hartford.

The data, as thus analyzed into certain fundamental units of measure, are capable of several other treatments, yielding additional information or checks upon the general accuracy of the work. It is possible, for example, to estimate total contributing populations above any given point, the effect of pools upon sedimentation and of rapids upon re-aëration throughout certain stretches, the effect of any stated degree of sewage treatment at certain points and any other matters of interest. Our present purpose has been merely to outline the manner in which this problem was attacked and the essentially fundamental nature of the data that have been recorded.

Discussion by Nathan B. Jacobs.*

The author of this paper has left open but little ground for discussion. In his usual thorough manner, he has covered the facts of the case so impartially that if his official connection with this litigation were not so well known, one would have difficulty in discerning which side of the case he had

*Of Morris Knowles Inc., Consulting Engineers, Pittsburgh, Pa.

represented. Now that this case is over, and the story is so well delineated, possibly many will wonder how such misunderstanding could arise as to cause this litigation to extend over a period of years. One almost feels that the doctrines laid down in this case have always been the rule, but this is possibly due to the fact that, in looking backward, one sees the facts only in the light of present established principles.

Possibly, the writer can make this clearer by referring to just one statement in the very beginning of the paper. In speaking of the diversion of the Nashua River, an interstate stream, by the construction of the Wachusett Reservoir, the author states "no question involving interstate water rights was raised." While the writer has no personal knowledge of the conditions at that time, it has always been his understanding that the interests of New Hampshire were so evident and well recognized that settlements for damages by release of water, the construction of sewers for the city of Nashua and compensation to New Hampshire mill owners, were made without litigation. The report of the State Board of Health was made in 1895. Before the legislation for the diversion of the Nashua was passed, in fact, even before the report was published, citizens of New Hampshire sought legal counsel as to the power of Massachusetts to authorize such a diversion. Eminent counsel stated, as published in the Harvard Law Review.*

> The Nashua and Jackson Manufacturing Companies desire an opinion as to the power of the Massachusetts legislature to authorize such diversion of the river, either with or without a provision for compensation to the New Hampshire riparian properties.
>
> We cannot bring ourselves to believe that such an act, in either form, will be passed by the Massachusetts legislature. . . .
>
> By parity of reasoning, Massachusetts could not authorize the construction of an aqueduct or canal in Massachusetts which would divert water from a stream naturally flowing to New Hampshire.

It is true, of course, that no interstate litigation occurred in connection with the Nashua River, but this was not due to the fact that "no question . . . was raised," but to the method which was adopted by the Metropolitan Commission in handling the question.

In 1900, the Merchants' Association of New York, through its Committee on Legislation, expressed the view that it would be impossible to divert a tributary of the Housatonic River, an interstate stream, for the purpose of developing a water supply for New York City. This opinion agreed with that on the Nashua River, previously referred to. The diversions of the Nashua were accomplished by amicable proceedings, but the rule stood that in the judgment of the legal authorities at that time it was not possible to extend the right of eminent domain so far as to permit the diversion of an interstate stream to such an extent as to compel the citizens of a lower riparian state to accept damages.

Mr. Eddy has called attention to the decision of the Supreme Court

* Vol. 8, No. 3, pp. 138 and 140, November, 1894.

in the Chicago Drainage Case, wherein the Sanitary District of Chicago was enjoined from continuing diversions of the Great Lakes in such a manner as to injure navigation and the rights of the other states of the Union. This case fits well into the picture. Chicago is not precluded from obtaining its water supply from interstate waters, but the district is to be restrained from damaging the citizens of other states. Both New York and Boston are permitted to obtain their water supply from interstate waters, but neither has established any rights as prior appropriator, nor the right to cause substantial damage to citizens of another state.

Before the decision in these cases, we knew of two water-rights doctrines in the United States — the riparian ownership of the East and the prior appropriation of the arid West, but as stated by the writer before the American Water Works Association, the practical result of these cases is to "forward the cause of stream regulation under a new doctrine of equality of right, assuring to an upper state full benefit from waters within its borders and to a lower state *immunity* from material damage."

This situation compels the developer of water supplies in upper states to consider carefully the effects on the lower states and to divert waters *in such a manner* as to effect no substantial damage to a sister state. It is the manner of diverting water, or rather *the time when* that is now most important. In the report of the Joint Board (Massachusetts Document 1550, 1922), the chief engineer recommended that diversion be limited to such time as the flow is in excess of 1.2 c.f.s. per sq. mile. On the Ware the Great and General Court increased this to approximately 1.34 c.f.s. per sq. mile but on the Swift it was reduced to 0.17 c.f.s. per sq. mile, with the result that the requirements of navigation compelled the modification of this amount and the release of stored waters.

Massachusetts was permitted, under the decision of the Supreme Court, to take approximately two per cent. of the flow of the Connecticut River, but this small amount is limited as to the manner in which it may be taken, both by the restrictions of the legislation of Massachusetts and by the communications of the Secretary of War. New York is permitted to divert approximately two and one-half times as much water from the Delaware River, in spite of the fact that it is a smaller stream; but New York is permitted to take this larger quantity *at such time and in such a manner* as to do no substantial damage in the lower states.

In other words, the fundamentals of fairness and equity seem to remain the same throughout the ages. These decisions hold that now, as in the past, the Golden Rule of doing unto others as you would have them do unto you applies to the taking of water from an interstate stream in such a manner as not to hurt one's neighbor.

GENERAL DISCUSSION.

Discussion by Harrison P. Eddy.*

These papers by Mr. Merriman and by Mr. Winsor show clearly the magnitude of the problem of securing adequate supplies of pure and wholesome water for the ever-increasing populations of our great metropolitan districts. In both cases, that of the Delaware River and that of the Swift and Ware rivers, much evidence was given on the question as to the relative stress which should be laid upon the original quality of sources of water supply.

It is interesting to note, therefore, the conclusions of the Special Master in each case. In the Connecticut-Massachusetts case Special Master Charles W. Bunn, referring to the proposed use of the Merrimack River as a source of supply, made the following statements in his report to the Supreme Court:

> The Connecticut water experts, and they are men of the highest qualifications and character, . . . whole-heartedly endorse the Merrimack as a water supply for Boston. And on the other hand as many witnesses of equally high qualifications and character called by Massachusetts utterly condemn the Merrimack. I think the experts on water and pollution called by the plaintiff and defendant are equally competent and honest in their views. The difference between them seems partly to be a difference between two schools of thought. One looks most favorably on the sinner repentant, the other will have none of him except on compulsion. The one school has the fullest confidence in the processes involved in modern treatment of polluted water and lays less stress on pure source of supply. It suffices them to feel that water will be delivered to the consumer pure. The other school is skeptical about the infallibility of water purification processes and seeks waters that are pure at the source. They advise all cities and municipalities to obtain pure waters wherever practical instead of treating polluted waters.

Again he stated:

> I have been much interested and impressed by the evidence of the water experts which puts it beyond question that polluted water by proper treatment may be made hygienic. The experts convince one that even sewage by proper treatment makes an innoxious beverage.
>
> Also I find, and there is no dispute on the subject, that many cities of Europe and of this country are using water probably as heavily charged with pollution as the Merrimack. London, England, Louisville, Cincinnati, St. Louis, Kansas City, New Orleans, are among these cities. But only one city was mentioned (Lawrence, Mass.) which uses polluted water when it can get a pure supply.

With further reference to this subject, the Special Master made the following statements, some of which have been quoted by Mr. Winsor, but are of sufficient significance to bear repetition:

> It seems to me that in determining a water supply due regard must be given to public opinion. Undoubtedly the Ware and Swift acts expressed the settled public opinion of the Boston District and of the state. Up to now the Metropolitan District has been using waters of fair purity; at least waters that have not yet required elaborate

*Of Metcalf & Eddy, Engineers, Boston, Mass.

treatment to fit them for drinking. The people of Massachusetts are not accustomed to fitting by modern treatment badly polluted waters. It is natural that such people should have a peculiar hostility to polluted water. Our governments in the long run are controlled by public opinion. And while an expert on water, acting in a strictly professional capacity, may say that he will disregard public opinion, municipal and other governments cannot take that stand. The courts it seems to me cannot close their eyes to the necessities imposed by public opinion on governments. Having found on the first branch of the case that Connecticut will not be substantially and seriously injured by the Ware-Swift diversion and the people of Massachusetts having made their decision in favor of the Ware and Swift, conceding that it is open to Connecticut to ask this court to overrule the Massachusetts determination and relegate Boston and the Metropolitan District to the water supplies in the eastern part of the state, certainly the burden is on Connecticut to make a peculiarly clear and conclusive showing. I content myself with finding that no such showing has been made. Giving the proof of Connecticut the utmost weight it no more than raises a doubt. The objections are too important and too many to the water supplies of northeastern Massachusetts to warrant a decree that Boston and the surrounding district *are bound* for the present and during the future to rely on the polluted waters of the Merrimack for drinking water.

The decision of the Supreme Court, delivered by Mr. Justice Butler, referred to these points in the following language:

The second plan is based on the taking of water from the Merrimack. That stream drains a large watershed mainly in New Hampshire. It is polluted and the pollution is practically beyond the control of Massachusetts. There is no certainty of its improvement or that it will not become worse. Unquestionably polluted water may be made wholesome by proper treatment. A considerable amount of industrial waste from mills, cellulose plants, tanneries, rendering works and gas works, of which there are many in New Hampshire, is peculiarly difficult to eliminate from water. The necessary treatment of waters so polluted involves several processes — storage for 30 to 90 days in a large reservoir, aëration, filtration, chlorination. These introduce a human element subject to weaknesses and failures of human nature. Instances of breakdowns are given. There is a small element of danger involved in every elaborate system of water purification. With a single exception, all the witnesses expressed preference for a supply of originally pure water over a purified polluted one. Lawrence is the only city in Massachusetts using Merrimack water for drinking. It consumes an extraordinary amount of bottled water the cost of which in 1916 was about 55 per cent. of the amount paid for public water for all purposes. The plan contemplates the taking of 200 million gallons per day from the Merrimack at Tyng's Island, just below the New Hampshire line. That is about one-quarter of its flow. Factories below the proposed takeout would be liable to suffer damage from the diversion. The stream is navigable below Haverhill and it is not certain whether the taking of that amount would be permitted by the Government. The Master says: "I find the taking from the Merrimack ought not to be imposed upon the Boston District. Because first the water is a polluted water and Massachusetts has no adequate control of the pollution or adequate remedy to cure it; that the water is of quality much inferior to the Ware and Swift and the proposed project inferior from an engineering standpoint to the reservoir and tunnel which the Ware and Swift Development involves."

The decision of the Court also contains the following significant paragraph, which has been quoted by Mr. Winsor:

Drinking and other domestic purposes are the highest uses of water. An ample supply of wholesome water is essential. Massachusetts, after elaborate research, decided to take the waters of the Ware and Swift rather than to rely on the sources in the eastern

part of the Commonwealth where all are or are liable to become polluted. We need not advert to other considerations, disclosed by the evidence and findings, to show that the proposed use of the waters of the Ware and Swift should not be enjoined.

In the Delaware River case, similar viewpoints were expressed by Hon. Charles N. Burch, the Special Master, who said:

. . . it is undoubtedly possible for the city of New York to obtain the additional quantity of water which it desires without resorting to the Delaware River tributaries. I think, however, the proof equally clearly shows that the water obtained from the Hudson River watershed would not be equally good in quality.

. . . I think it may be fairly assumed that the city of New York considers the Delaware source of supply the most economic, but, whatever the cost may be, whether greater from one source or from another, the controlling consideration, in my mind, is that a purer and better water is obtained from the Delaware tributaries than from any other source.

. . . I think New York may rightfully insist that it is entitled to the best water and the most constantly reliable supply of water, even though the cost should turn out to be greater.

. . . I am of the opinion . . . that New York has the right to resort to the source of supply of its own selection in order to obtain the purest water and the best water, the supply of which is furnished by gravity rather than by human agency, provided, the obtaining of water from the Delaware sources does not unreasonably affect the state of New Jersey and its people. There was much evidence as to the desirability of obtaining pure water in the first instance rather than of obtaining water not so pure and thereafter purifying it.

I think, undoubtedly, it is a sound principle that the purest natural water should be obtained rather than relying upon filtration, chlorination or other means of purification to furnish equally good water.

Again the Special Master said:

While I am of the opinion, as stated, that New York City has adopted the plan which is least expensive, yet, as already stated, I do not deem that consideration controlling. I repeat that it clearly appears that the best and purest water for the municipal water supply of New York City is the water from the Delaware River tributaries. I think in a matter involving the health and welfare of a city of nearly seven million people, that source of supply may properly be selected which furnishes the purest and best water, even though it may involve an additional cost over obtaining water in the Hudson watershed or from Long Island — though, as already stated, I think the evidence fails to show that the expense of obtaining water from the Hudson watershed or from Long Island will be less than obtaining water from the Delaware tributaries.

One of the findings of fact made by the Special Master in the Delaware River case was as follows:

The modern tendency is to obtain for municipal supply the purest water possible and to make this water better and not to obtain less desirable water and render it acceptable by treatment and purification, though insuperable economic considerations frequently compel the latter course.

The Supreme Court itself, in an opinion delivered by Mr. Justice Holmes, stated:

. . . the New York plan as qualified here is reasonably necessary. Some plan must be found and soon acted upon, and taking into account the superior quality of the water and the other advantages of the proposed site over others it at least is not arbitrary or beyond the freedom of choice that must be left to New York.

In the recent Chicago Drainage Canal case a somewhat similar opinion was expressed by the Special Master, Hon. Charles E. Hughes, now Chief Justice of the United States, who referred to the matter as follows:

The complainants ask that the decree provide that on and after the date fixed for the completion of the sewage treatment program, the state of Illinois, the Sanitary District, and all persons acting under the authority of either, be ordered to refrain from so polluting the Chicago River, and the auxiliary navigable channels of the Sanitary District, by the discharge of sewage or otherwise as to create an obstruction to or interference with navigation or navigable capacity. It seems to me that the best way, and the reasonably sure way, of accomplishing this result is to permit an outflow from the Drainage Canal at Lockport. The suggestion that outfall sewers or tunnels might be built to take the effluents directly to Lake Michigan has been made in a general way, but the evidence is by no means convincing that it would be a reasonable requirement to compel the Sanitary District or the city to build such sewers or tunnels to take the effluents from the sewage treatment plants across the city to the Lake. . . . The problem of the storm flow would still remain and would be especially serious in view of the volume which may be expected in the run-off of this large area with its great and growing population. The pumping of circulating water into the Drainage Canal and the Chicago and Calumet Rivers would, as pointed out in the testimony . . . carry whatever filth there would be in these rivers to the Lake more rapidly. It is not clear that this course would be compatible with the interests of navigation in the Chicago harbor; and that there would be a serious danger of contaminating the water supply and of creating offensive conditions at the bathing beaches of the city is quite evident. As to the water supply, it is urged that water filtration plants should be constructed. The fact remains that the effluents from the sewage treatment plants and the storm water must go somewhere, and if they are taken away from the Lake and discharged through the canal at Lockport, both the danger to the water supply will be removed and conditions suitable to navigation can be maintained.

Mr. Justice Holmes, in delivering the opinion of the Supreme Court, referred to the discharge of sewage effluent from Chicago treatment plants into Lake Michigan, the source of the city's water supply, in the following terms:

Perhaps the complainants would not be very insistent with regard to the 1 000 or 1 500 c.f.s. which earlier in this case they seemed to admit to be reasonable, if their demand were allowed that the domestic pumpage be purified and returned to the Lake — a demand not contemplated by their bill. But purification is not absolute. How nearly perfect it will be with the colossal works that the defendants have started is somewhat a matter of speculation. The Master estimates that with efficient operation the proposed treatment should reach an average of 85 per cent. purification and probably will be 90 per cent. or more. Even so we are somewhat surprised that the complainants should desire the effluent returned. The withdrawal of water for domestic purposes is not assailed by the complainants and we are of opinion that the course recommended by the Master is more reasonable than the opposite demand.

Discussion by Ezra B. Whitman.*

The writer first was brought into the Delaware River case in connection with the Tri-State Compacts between New Jersey, New York and Penn-

*Consulting Engineer, Baltimore, Md.

sylvania. Although Mr. Merriman thinks it was purely a political consideration which made New Jersey fight the compacts, the writer knows that the circumstances connected with the opposition do not support this view. The manner in which this opposition started was as follows: The writer was sitting in his office one day when Mr. Abram Swan, Jr., Commissioner of Public Works of Trenton, N. J., came in and said: "Mr. Whitman, there has been a compact presented to the Legislature that we think is harmful to Trenton's interests. Now, we want to secure the services of someone who has had experience in studying questions of this kind, and we would like you to come up to Trenton and review the terms of the proposed compact for us, and if no harm will be done to Trenton in carrying out this compact, we are ready to support it, but if there is any harm which Trenton will suffer, then we want to fight." That was the writer's commission to study the compact.

The compact provided not for 600 m.g.d. to be taken from the river, but for 2 100 m.g.d.; about one-third of the flow of the river was thus to be taken before it reached Trenton. The compact provided that no diversion would be made from the streams above Tri-State Rock, which is at the intersection of the boundaries of New Jersey, New York and Pennsylvania, when the flow in these streams was less than 0.45 c.f.s. per sq. mile. Below Tri-State Rock, it provided that the diversion from the stream could be made of all water in excess of 0.24 c.f.s. per sq. mile. A careful study of the records of the stream flow at Trenton shows that over a period of sixteen years, there was only one month in which the flow of the stream averaged as low as 0.24 c.f.s. per sq. mile. With the complete diversion of 2 100 m.g.d. from the stream, our studies showed that there would be periods of from three to six months' duration when the flow of the stream past Trenton would be reduced to this minimum monthly flow which occurred over a period of sixteen years.

The writer went into the matter just as carefully and as thoroughly as he could and studied all the data in connection with it, and it was his unqualified opinion that if that compact were carried through, the city of Trenton would be injured, and he thinks that the decision of the Supreme Court, reducing to 440 m.g.d. the 600 m.g.d. contemplated to be taken out of the river by New York, sustained his judgment that there would be injury to the citizens of Trenton.

In fact, the writer thinks the trouble with the whole situation in regard to the drawing of the compacts was that the engineers who drew those compacts were interested mainly in the water supplies for New York City, the northern New Jersey towns and Philadelphia; all other matters like navigation, water power, sanitation, recreation, agriculture, fish and oysters received very little consideration in drawing up the terms of the compacts.

Personally, the writer has always been opposed to the riparian law which says that no use can be made of water flowing in a stream, but that it must be allowed to flow undiminished, in its pristine purity, down the stream.

What he thinks should be done, not only with the Delaware River and with the Connecticut River, but with every one of our big rivers throughout the country, is that there should be an unbiased commission to study the uses of each river and how that river can best be developed to bring the greatest good to the greatest number of people, taking into account all of those uses which have been previously mentioned, that is, water supply, navigation, power, sanitation, recreation, agriculture and the fish and oyster industries. What the writer has in mind was much better expressed by President Herbert Hoover in his speech of acceptance on August 11, 1928: "Moreover, the time has arrived when we must undertake a larger visioned development of our water resources. Every drop which runs to the sea without yielding its full economic service is a waste. Nearly all of our greater drainages contain within themselves possibilities of cheapened transportation, irrigation, reclamation, domestic water supply, hydroelectric power and frequently the necessities of flood control. But this development of our waters requires more definite national policies in the systematic coordination of those different works upon each drainage area. We have wasted scores of millions by projects undertaken not as a part of a whole but as the consequence of purely local demands."

The writer thinks that a great many things were brought out in the trial of the Delaware River case which had been given practically no consideration in drawing the compact; in fact, in informal discussion the engineers who helped to draw the compact have admitted that this was the case.

There is one other point that the writer wants to bring up in connection with Mr. Merriman's statement that New Jersey had made a study of the pollution of the waters of the Delaware River in New York State from the summertime population who lived on these watersheds during their vacation and recreation periods. The author intimated that New Jersey wanted to stop the use of these streams for recreation in New York, while she wanted the stream protected for recreation in New Jersey. The writer had charge of the studies of the pollution of the streams in New York State. They were not made for the purpose of saying that there shall be recreation in New Jersey and not in New York, but in answer to a statement made by New York on page 20 of the "Motion for Leave to File Answer, for Leave to Withdraw and Amend, and Answer." In the thirty-third paragraph of this motion, the following statement was made: "The waters of the tributaries of the Delaware River which rise within the territorial confines of the state of New York flow into the channel of the Delaware River in clean, wholesome and sanitary condition. Such pollution as the plaintiff in its bill of complaint refers to, if any such there be, originates from sources within its own boundaries and from other sources outside the state of New York." It was in answer to this paragraph, that the studies were made to show that the waters were not pure and undefiled as they came from New York State.

Turning now to the Connecticut case, in connection with the water power at Windsor Locks. Over $60 000 was spent in making borings and preparing plans for the development of power on the Connecticut River at Windsor Locks, and application was made to the Federal Power Commission for a permit to develop the water power at that location.

There is one other point which the writer would like to bring out in connection with water power studies and the diversion of water. With the average water power development competing with the modern steam plant, it is a very close question whether or not the water power development will be commercially profitable and earn a return upon the money which will be invested in the water power development. The Federal Power Commission in the Conowingo development on the Susquehanna River, limited the return on the money invested in this project to seven per cent. of its actual cost. As illustrating the point the writer wishes to make,—if there is a hydro-electric development which costs one million dollars to develop, the company would be entitled to earn seven per cent. or $70 000, out of which it would be necessary to pay interest on its bonds or securities, and to pay a dividend on the common stock; the fair return on the property would be $70 000. If the company receives $200 000 as its gross income, which is approximately what such a property would be expected to earn, and two per cent. is cut from the entire power which can be developed at that site, this two per cent. practically all comes from the net income. In other words, with the million dollar property described, if the available water supply is cut down, the available power production is also cut while the same dam, lands, roads and transmission lines must still be built and the amount invested would not be appreciably diminished. With the $200 000 gross income diminished by two per cent., it would mean a loss of $4 000 from the $70 000 net. Instead of being a two per cent. reduction in the net or in the fair return, it would be a $5\frac{3}{4}$ per cent. reduction. If five per cent. of the water is diverted the fair return is reduced by 14.3 per cent., and if the reduction in available water is ten per cent., the fair return is reduced by $28\frac{1}{2}$ per cent., while a twenty per cent. diversion of water will reduce the fair return by $57\frac{1}{2}$ per cent. In other words, a small reduction in the flow of the river and the amount of power which can be produced and sold, makes a tremendous difference in the financial aspect of the situation when one is studying the commercial possibilities of a power development. The facts as above given would be true with the complete regulation of the stream which has taken place in only a few instances throughout the country. Many of our streams, however, are being developed without complete regulation where the water wheels are of such capacity that they will take the entire output of the river for about nine months during the year, and the tendency is to avoid wasting less and less of the flood flows of the streams by the installation of greater wheel capacity.

Whenever diversion of water from a stream takes place, there is no question that something has been taken from the lower riparian owners.

To establish the value of this diversion in dollars and cents is an extremely difficult thing. This problem has been handled in England in a very intelligent manner by providing for compensation water. There is no question that the flood flows of streams cannot be wholly used in many cases; in fact, they may actually be harmful. In a number of places in England where water has been diverted, the diverter has been allowed to take approximately two-thirds of the entire yield of the stream, but has been compelled to let down as compensation in kind, approximately one-third of the flow of water in the stream. In England, the terms of compensation in kind are fixed by Parliament in each instance after due hearings. The needs for water power, water for industrial uses, navigation and fisheries are taken into consideration. The amount of compensation water is fixed as a definite proportion of a net available flow. In England, if the low-water flow for one week is taken as representing the normal minimum flow, the compensation flow ranges from two to fourteen times the normal minimum flow. This is many times higher than the flows proposed to be released either by Massachusetts or New York. If one-third of the entire available flow is released and two-thirds permitted to be diverted, this one-third can be let down in such a way that many of the riparian interests are improved. This improvement would be the compensation for permitting two-thirds of the water to be diverted. It is my belief that a proper allowance of compensation water will provide the basis for an equitable solution, or for a solution as nearly equitable as possible, where diversion takes place.

Discussion by Robert Spurr Weston.*

It seems that in these comprehensive papers by Messrs. Winsor and Merriman, and in the discussions which have followed, the decisions of the Court have been elucidated in so far as they are of interest to water-works men. However, it may perhaps be permitted to one who served the Commonwealth of Massachusetts in the earlier case and the Commonwealth of Pennsylvania in the later one to make some comparisons of data which had an effect upon the decisions.

Excellent maps have been presented with the two papers discussed. From these and the testimony the following table has been compiled.

The non-tidal portion of the Connecticut catchment area is nearly half again as much as the corresponding area of the Delaware above Trenton. On the other hand the total catchment area of the Delaware at its mouth is about 20 per cent. greater than that of the Connecticut. Notwithstanding the larger non-tidal area of the Connecticut the actual taking is very much less, New York alone being permitted to take 440 m.g.d., and if the allotments pleaded for in the case, namely 600 m.g.d. for New York, 400 m.g.d. for New Jersey and 750 m.g.d. for Pennsylvania, were allowed in the future, the taking would be 15.3 per cent. of the yield of the catch-

*Of Weston and Sampson, Boston, Mass.

Item.	Connecticut River Case.	Item.	Delaware River Case.
Catchment Area — Square Miles.			
Ware River at Coldbrook	98	Delaware River at Points of Taking	610
Swift River at Point of Diversion	186	Delaware River at Points of Taking as reduced by Decision	446
Ware River, Total	221	Delaware River at Port Jervis, N. Y.	3 070
Swift River, Total	213	Delaware River at Belvidere, N. J.	4 540
Chicopee River	719	Delaware River at Riegelsville, N. J.	6 190
Connecticut River at upper Massachusetts boundary	6 816	Delaware River at Trenton, N. J.	6 800
Connecticut River at Sunderland	8 000	Delaware River at Delaware State Line	10 444
Connecticut River at Massachusetts-Connecticut Line	9 724		
Total	11 350	Total	13 660
Mean Discharge — Cubic Feet Per Second.			
Connecticut at Sunderland	14 000	Delaware River at Port Jervis	5 648
Connecticut at Massachusetts-Connecticut Line	17 000	Delaware River at Trenton	11 492
Ware at Diversion Point	154	Upper Delaware at Diversion Points	956
Swift at Diversion Point	300		
Mean Discharge — Cubic Feet Per Second Per Square Mile.			
Connecticut at Sunderland	1.75	Delaware at Port Jervis	1.84
Connecticut at Massachusetts-Connecticut Line	1.75	Delaware at Riegelsville	1.78
Ware at Coldbrook	1.57	Delaware at Trenton	1.69
Swift at Diversion Point	1.61	New York Diversion Area	2.2
Yields — Million Gallons Daily.			
Yield of Diversion Area — Ware*	30	Yield of Diversion Area asked by New York	600
Yield of Diversion Area — Swift*	161	Yield of Diversion Area as Decreed	440
		Yield Necessary for Eastern Pennsylvania in Future	750
		Yield Necessary for Northeastern New Jersey in Future	400
Total reasonable ultimate yield from sources	191	Total reasonable ultimate yield from sources	1 750

*Until the Swift Reservoir is completed the yield of the Ware is estimated at 30 m.g.d. after the completion of the reservoir the estimated combined yield is 191 m.g.d.

ment area as compared with 2 per cent. in the case of the Massachusetts taking.

These differences must have had a considerable bearing on the decree of the Court which reduced New York's taking over 26 per cent. and dismissed without prejudice the request of Pennsylvania for an allotment, — not because of the 750 m.g.d. asked for, to be sure — but because Pennsylvania has not as yet any definite authorized plan for the use of the water of the Upper Delaware.

In the Massachusetts case the water is to be diverted from the watershed. This is also true in the case of New York, also of New Jersey, were that state to supply its northeastern counties from the Delaware, as it must do eventually. In the case of Pennsylvania, however, there would be no diversion from the watershed.

The cultural conditions are even more apart than those of water supply, even though the Upper Delaware and the Swift catchment areas will yield water of similar character and from regions which are declining in permanent population. The Delaware area, however, is increasingly used for summer residence.

The Ware River below the point of taking, at Coldbrook, and the Connecticut and its tributaries in Massachusetts are well developed for water power. On the other hand no dams may be built on the Delaware because of a colonial agreement between Pennsylvania and New Jersey, an agreement made in the interests of commercial navigation which no longer exists. Consequently, Massachusetts takes but the flood waters of the Ware although it makes large use of the waters of the Swift.

The large proposed takings by New York and the suggested takings by Pennsylvania were opposed by Trenton and other New Jersey cities on the Delaware which derive their domestic and industrial water supplies from the river. These supported the case actively, while the large cities in the northeasterly counties, comprising more than half the population of the state, were apathetic and their officials took no part in the controversy. In Massachusetts and Connecticut, none of the municipal water supplies are taken from the Connecticut itself although Springfield, Holyoke, Northampton, Hartford and smaller municipalities have developed supplies on its tributaries.

The population, mostly unsewered, contributing to the Connecticut at the northerly Massachusetts state boundary is only 199 000, although the density of population increases rapidly between Northampton and Hartford. On the Delaware, on the other hand, there is the considerable city of Port Jervis discharging its sewage above Tri-State Rock where the three states join. Below Port Jervis the river purifies itself receiving fresh accessions of sewage at the Delaware Water Gap and below the mouth of the Lehigh, but becoming purified in great measure before reaching Trenton where is located the intake of the city's water supply. Below Trenton, while the population is heavy, the opportunities for aëration are so great that the diversion of relatively small amounts of water is insignificant.

In the discussion of Mr. Winsor's paper by Professor Phelps and the writer, the population equivalents at the Massachusetts-Connecticut state line are given. It is interesting to compare these with similar figures introduced as evidence by Pennsylvania which were well supported by the analyses of the New Jersey witnesses. They are as follows:

COMPARISON OF POPULATION
CAPACITIES WITH PENNSYLVANIA PLAN OF RELEASE.
Population Capacity (Thousands).

Month 1929.	Connecticut River at Mass.-Conn. State Line.	Delaware River at Trenton, N. J.		
		As Observed.	With N. Y. taking 600 m.g.d.	With 3 states taking 1 750 m.g.d.
July	649	357	389	358
August	368	335	374	353
September	416	496	522	438
Average	478	404	436	388

The population capacity of the Connecticut was computed for the time required for the water to reach Rocky Hill, some miles below Hartford; the capacity of the Delaware was computed for the stretch between Trenton and Philadelphia. The increase in population capacity which the New York taking would effect is of course due to releases under the Pennsylvania plan. With three states taking during dry months, like those of record, the effect of releases would be overcome and some decrease in population caused. The capacities in the table make no allowance for re-aëration in the stream below.

An attempt was made by New Jersey to show that diversions in New York State would proportionally increase the *Bact. coli* content at Trenton. However, when the flows and Dr. Rudolf's results of determinations of *Bact. coli* were plotted on a diagram with the stream flows, little relation could be seen between them. Some of the highest flows and lowest *Bact. coli* numbers occurred together and *vice versa*; the lowest numbers occurred with medium flows. This shows that the increased concentration due to distant takings would not affect the *Bact. coli* content at Trenton materially.

One rather surprising result of the study of the Delaware River was the effect of varying stream discharges upon hardness of the water. The following table shows the hardnesses and corresponding discharges of the Delaware at the large power plant at Holland, N. J. about 46 miles above Trenton. (Diagram 3064 — Exhibit 438.)

Stream Discharge cu. ft. per second.	Hardness p.p.m.	Stream Discharge cu. ft. per second.	Hardness. p.p.m
53 000	21	5 100	56
33 000	25	4 100	61
25 000	30	3 600	66
17 500	37	3 000	74
12 600	42	2 300	84
9 100	47	2 000	89
7 000	51	1 900	94

It will be noted that at times of decreasing low flows the hardness rapidly approaches that of the ground water, while at times of increasing high flows it approaches that of the quick run-off. It may be further noted that large diversions of flood waters may be made without affecting the hardness while relatively small additions of compensation water, as decreed by the Court, will markedly decrease the hardness. Similar data are now being collected on the Ware and Chicopee rivers, but the results are not yet forthcoming.

There are considerable discharges of sulphates from the Lehigh River which receives hard waters from the limestone regions above and the acid discharges of coal mines and steel works; yet variations in discharge affect but slightly the sulphates as determined at the Torresdale water purification plant of the city of Philadelphia. The relation between stream discharges and sulphates was as follows:

Stream Discharge cu. ft. per second.	Sulphates p.p.m.	Stream Discharge cu. ft. per second.	Sulphates p.p.m.
30 000	15.0	5 000	18.0
15 000	15.5	2 500	21.0
10 000	16.2	2 000	22.3

This table shows how inconsequential would be the effect of diverting even 1 750 m.g.d. or 2 700 cu. ft. per second from an average of about 12 000 cu. ft. per second while the compensation water let down in dry weather would produce a correspondingly greater decrease in sulphates per unit of stream discharge.

There are many other interesting details in connection with these two cases which would be useful to students of water problems in the future and which may not be presented here, because of their bulk.

After the evidence was all in, brackish water appeared in the Lower Delaware in concentrations never before observed, greatly affecting the industries along the river as well as the water supply of the city of Chester. Because the occurrence was so unusual and the effect of the proposed diversions and releases upon water indeterminate, Pennsylvania asked that the case be retained in court and appropriated $50 000 for a two years' study of the problem. This study is now in progress. The Court decreed that the case be retained in court and that proper application for relief may hereafter be made by any party thereto as to any matter determined without prejudice and also for modification of any of the provisions of the decree regarding takings and releases and the treatment of sewage and industrial wastes at Port Jervis.

The best statement of the case in a few words, which the writer has heard, is that of Mr. George G. Chandler who appeared for Pennsylvania after Mr. Justice Roberts was raised to the Supreme Bench. Mr. Chandler's statement is as follows:

The Supreme Court of the United States has declared that the diversion and use of interstate waters is not governed by the local law of the

litigant states but is controlled by interstate common law, a guiding principle of which is equitable apportionment. Under such an apportionment, each state is entitled to its fair share; a priority of appropriation confers no superiority of right.

Furthermore, the diversion of interstate waters, even to another watershed, will be permitted in the absence of proof of substantial damage resulting therefrom, but subject always to the approval of federal authorities respecting navigation. The selection of interstate waters as a source of supply is primarily a matter of state sovereignty, providing sister states do not thereby suffer injury of serious magnitude. As an incident to such a selection, the Court may prescribe as a condition that compensation water be released from the impounding reservoirs.

BOOK REVIEW.

THE SIGNIFICANCE OF WATERBORNE TYPHOID FEVER OUTBREAKS 1920–1930. By Abel Wolman and Arthur E. Gorman with a foreword by Thomas Parran, Jr., M.D. The Williams and Wilkins Co., Baltimore. Cloth; 6 x 9 in.; pp. 82. Tables and charts. $2.00.

The material presented in this volume is in the nature of a statistical survey of waterborne typhoid fever and dysentery outbreaks in the United States and typhoid fever outbreaks in Canada for the decade 1920 to 1929 inclusive. The book presents an extension of the data given in a paper by the authors in the American Journal of Public Health, February 1931. There are numerous tables and diagrams to illustrate the trend of the typhoid death rate for the period studied, the number of outbreaks in this country and Canada, the classification of outbreaks as to population groups affected and as to the point of pollution in water systems, the number of cases and deaths in the twenty-five largest outbreaks of typhoid fever and the cases of dysentery, the classification of outbreaks as to causes and yearly distribution of cases and deaths, the annual distribution by States of waterborne typhoid cases, deaths and dysentery cases and the classification by causes according to States of waterborne typhoid cases, deaths and dysentery cases.

Seven pages are devoted to a review of some of the more important outbreaks of waterborne disease in foreign countries. The authors conclude that the causes have been much the same as on this continent and that 90 per cent. of the epidemics studied were preventable.

The last 31 pages of the book are given over to a chronological record of waterborne outbreaks in the United States and Canada for the decade 1920–1929. This record is arranged by States and Provinces and includes such information as the place, time, cause, number of cases and deaths of the outbreak listed, the source and treatment of the water supply and the classification of the outbreak according to the system of causes devised by the authors. In the case of some States, as Pennsylvania, the name of the town or city is omitted, the outbreak being designated by letter. This unfortunate suppression makes somewhat less valuable the use of the record for purposes of study. As an historical contribution on the subject of waterborne outbreaks this rather lengthy compendium has considerable value.

The information and data collected by the authors were extensive. Reports were received from 47 states and 6 provinces, representing 98.65 per cent. of the population of the United States and 79.5 per cent. of that of Canada. The studies presented should be of interest to public health and water-works officials, particularly to the latter.

The number of waterborne outbreaks of typhoid fever and dysentery showed no tendency to decline in the decade under study. There were 26 in 1920 in the United States and 26 in 1929, with 30 in 1927, a year of floods. This number is too high in the opinion of the authors and reflects a laxity in control of the quality of water supplies that is deplorable. The announced aim of the book is to uncover "the weaknesses of administrative prevention of typhoid fever incidence . . . . insofar as they apply to those cases of waterborne origin."

The authors state that it is feasible to eliminate waterborne diseases in their entirety and paint a glowing picture of the lack of responsibility shown by public health officials and waterworks operators. To the reviewer's mind they go too far in their condemnation. It is his opinion that the last decade has shown a growing sense of responsibility on the part of the water-works profession and that many of the unfortunate occurrences to which the authors point can be shown to be due to hampering influences imposed by political conditions and by a public none too well educated in water-works

needs. The reviewer cannot subscribe to the statement in the foreword that "the deplorable negligence of water plant operators has resulted in a loss of confidence on the part of the public." The public is usually proud of its water works, although not altogether conversant with its needs.

The studies presented seem to show a much higher percentage of outbreaks in small towns, those under 5 000 population. This is an unfortunate circumstance, for the number of small towns and their total population is very large.

Another conclusion reached by the authors is that 40 per cent. of the outbreaks and three-fourths of the waterborne illness in the United States during the decade studied were due to defects in collection, treatment, storage or distribution of drinking water, and not to pollution at the source. Some of these outbreaks were undoubtedly due to gross negligence but it is hard to entertain the belief that all could have been prevented when such factors as acts of Providence and human fallibility are involved.

The most important single cause of outbreaks was that of unprotected cross-connections between polluted fire or auxiliary supplies and public systems.

A few pages of the book are devoted to the important subject of damage suits in connection with waterborne outbreaks. Specific cases of court action are cited for several cities showing that municipalities and private water companies are to an increasing extent now subject to heavy financial damages where it is possible to show that negligence has been involved.

Two mistakes have been noted in the book. On page 3 it is stated "the present decade opened with a (typhoid) rate of 35.8." Inspection of the diagram presented shows that this figure refers to the year 1900, not 1920. The other error is on page 4, where the number of outbreaks for 1927 is given as 31. The accompanying table gives the number as 30.

The authors have collected much valuable information and have made an interesting study of it. Controversy may arise, however, over some of the conclusions that are brought forward.

MELVILLE C. WHIPPLE.

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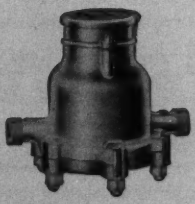

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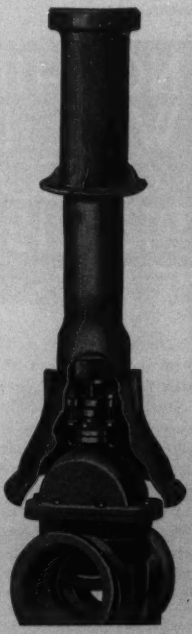

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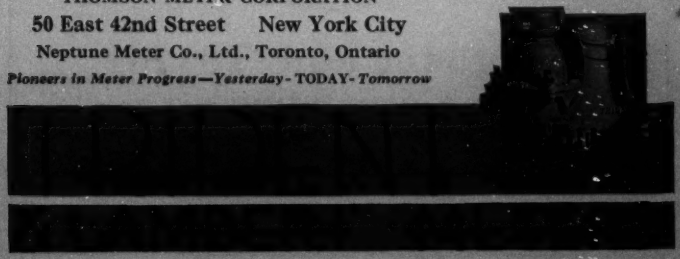

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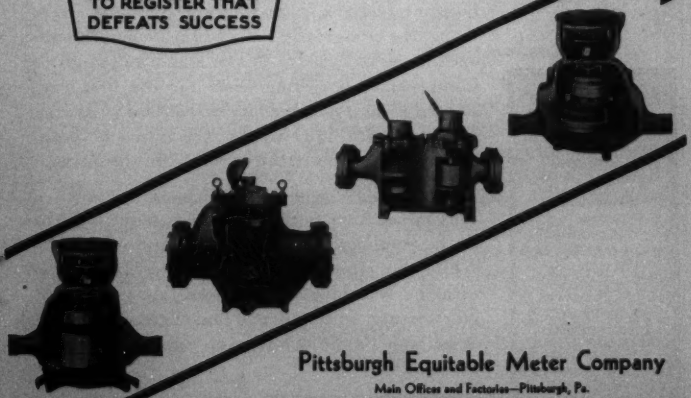

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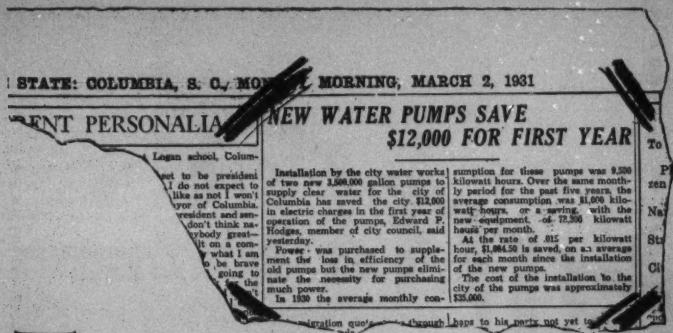
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Installation by the city water works of two new 3,500,000 gallon pumps to supply clear water for the city of Columbia has saved the city $12,000 in electric charges in the first year of operation of the pumps, Edward P. Hodges, member of city council, said yesterday.

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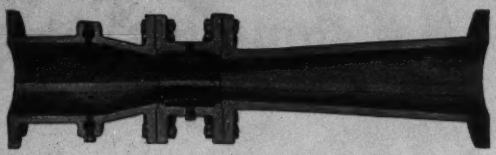

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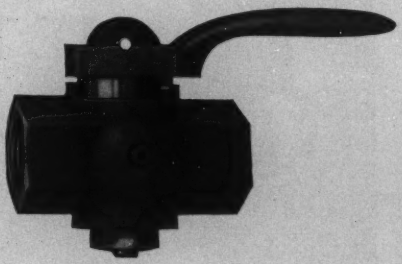

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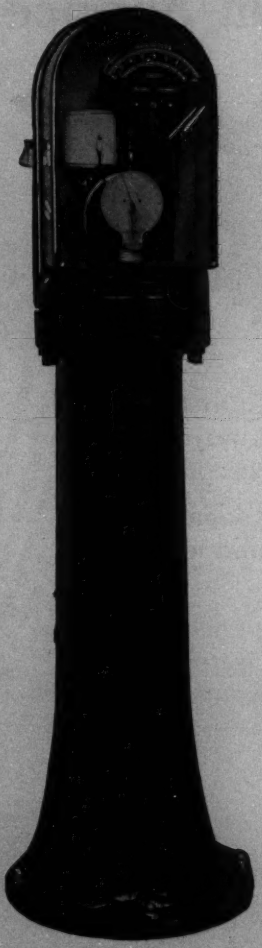
Easy Turning Stops
Alarm Signals



SIMPLEX
VENTURI TYPE
METERS

Indicate the flow on a uniformly graduated dial.

Record the flow on a rectangular chart with uniform graduations.

Totalize the flow on a five-dial totalizer, so designed that the last figure can be read with accuracy on a much larger scale.

They may be furnished for floor stand, wall bracket or panel mounting.

May be used for pump discharge — gravity supply — in the Filter Plant — or Sewage Treatment Works.

Simplex Meter Registers may be checked at any time while in service by use of apparatus furnished as standard equipment — an exclusive feature of the Simplex Meter.

Simplex Meters are the choice of many who value quality and accuracy above initial cost.

Write for data.

Simplex Valve and Meter Co.

6757 Upland St., Philadelphia, Pa.

"WATCH DOG" WATER METERS

ACCURATE *DURABLE*

DISC, CURRENT AND COMPOUND TYPES

Inquiries Solicited

GAMON METER COMPANY

NEWARK NEW JERSEY

METERS

The Kind You Want—As Many As You Want—When You Want Them

Six distinct types. All wanted sizes. Highest quality. All backed by a meter making experience of over sixty years. Remember the names:— **Empire, Nash, Crown, Gem, Empire-Compound and Premier.**

Especially remember the **Empire** (illustrated), the famous Oscillating Piston meter, which measures more accurately, is longer lived and lower in upkeep cost than any other.

Send postal for our meter literature.

NATIONAL METER COMPANY

299 Broadway, New York

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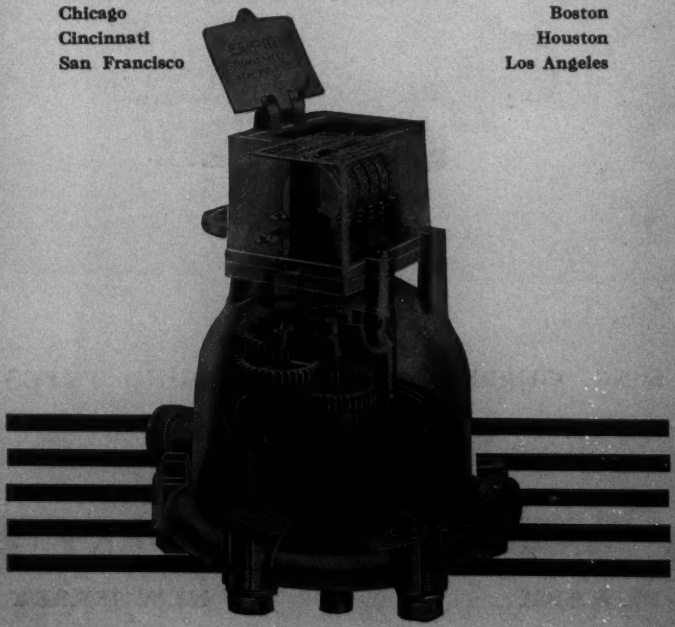
Los Angeles

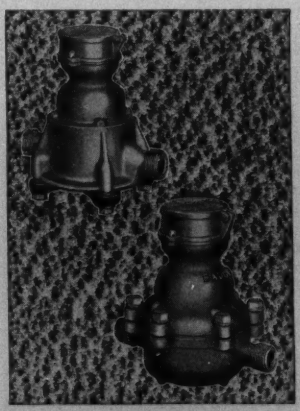


MAINTENANCE

—service must carry on at any price!

Destructive storms sweep down their courses, causing costly damage—undoing work well done —But the pause is short-lived, lines are put back in condition, communication, transportation, and supplies must carry on regardless of cost.

In a like measure, should trouble arise on lines equipped with Badger Water Meters, the lull in service is comparatively small—for Badgers show surprisingly low maintenance costs. This is due to simplicity of design and unit assembly. A complete unit can be replaced in less time because it is readily accessible—at low labor costs—with less loss in service—a worth-while Badger feature.



Badger disc meters have the largest capacities, size for size, with the least absorption of pressure and are especially sensitive and accurate on small streams as well as the maximum capacity flows. They are made under the most exacting manufacturing processes known to long experienced and successful meter manufacturers.

Know Badger Meters better. You can have full details by writing for bulletin No. 300.

BADGER METER MANUFACTURING CO., Milwaukee, Wisconsin

NEW YORK CITY
CINCINNATI, OHIO
CHICAGO, ILL.

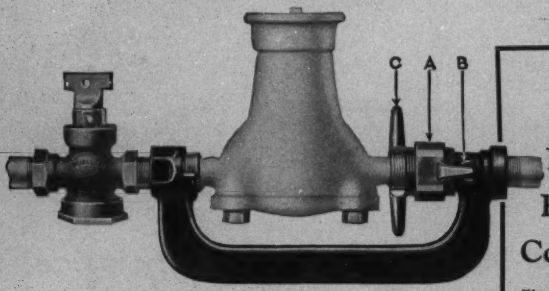
BRANCH OFFICES IN
LOS ANGELES, CALIF.
WACO, TEXAS
SAVANNAH, GA.

SEATTLE, WASH.
PHILADELPHIA, PA.
KANSAS CITY, MO.

BADGER Water METERS

NEW!

MUELLER . . . Straight-Line Water Meter Yoke



Better than ordinary Union Couplings economical to use in replacing them

THIS new Straight-Line Water Meter Yoke meets the demand for a simple, sturdy and effective setting for meter box installations and basement settings. A distinct improvement over ordinary union couplings, it saves time and money on the job because of these 4 exclusive features:

1. It acts as a spacer when putting in the meter;
2. It permits the meter to be put in or removed quickly and easily, any time;
3. It braces the pipes when the meter is out;
4. It provides *positive* means of *preventing the use of water without the company's knowledge* when the expansion connection is removed.

Because of the simplicity of its design, the Straight-Line Water Meter Yoke can be sold at a price which permits its economical use in replacing ordinary union couplings.

MUELLER CO. (Established 1857) *Factory:* Decatur, Illinois. *Branches:* New York, Dallas, Atlanta, Los Angeles, San Francisco, Chicago. *Canadian Factory:* MUELLER, Limited, Sarnia.

NEW Improved Expansion Connection

The expansion connection of the Straight-Line Water Meter Yoke is also new in design, incorporating several distinct advantages. Note them in the above illustration, as follows:—

Brass Sleeve (A) is locked to yoke by hook (B) which prevents it from turning forward when meter is being removed;

The spindle (C) is equipped with two prongs for hand tightening or for greater leverage with MUELLER Multiple Wrench or ½-inch nipple.

The expansion connection has only two leather gasket joints, and these are tightened automatically when the meter is tightened in place. The connection may be left attached or removed instantly, as desired.

MUELLER

Trade-Mark Reg. U.S. Pat. Office

Write today for complete information about the new MUELLER Straight-Line Water Meter Yoke and other Waterworks Specialties.

ATTENTION
WATER WORKS
OF NEW ENGLAND

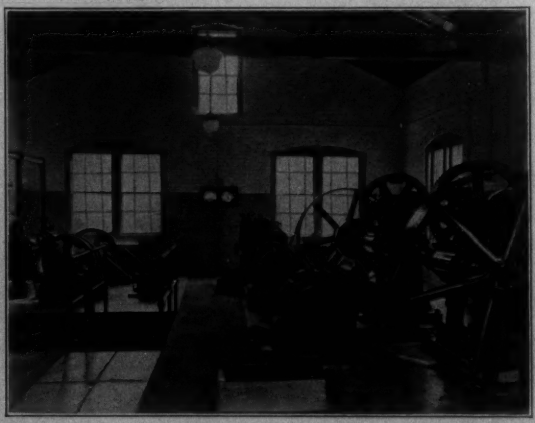
A few reasons why we solicit your inquiries on Water-Works Pumping Equipment:

First. — We make a specialty of furnishing Complete Water-Works Pumping Units of all types.

Second. — Total responsibility of installation is assumed by us.

Third. — We relieve the purchaser of every detail and turn the complete unit over to him under actual operation and with guarantee.

Fourth. — Every unit installed to date has exceeded its guarantee and has been completely accepted.



Remodeled Pumping Station at Bridgewater, Mass., completely installed by F. A. Mazzur Co., Inc. Barbour & Dixon, Eng'r's.

F. A. Mazzur Co., Inc.

141 MILK STREET, BOSTON

MINERALEAD

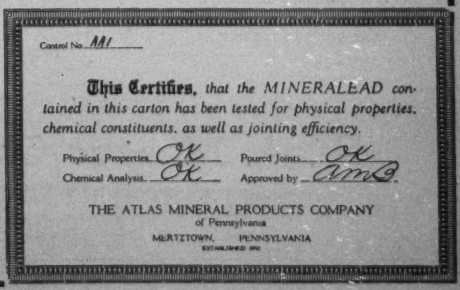
A PROVEN JOINTING MATERIAL FOR WATER MAINS

ABSOLUTE UNIFORMITY

Easy Melting
Rapid Pouring
No Caulking
Tighter Joints
No Radial Cracks

Is checked systematically to insure perfect performance.

Write for Catalogue


Control No. 441
This Certifies, that the MINERALEAD contained in this carton has been tested for physical properties, chemical constituents, as well as jointing efficiency.
Physical Properties OK
Poured Joints OK
Chemical Analysis OK
Approved by AMG
THE ATLAS MINERAL PRODUCTS COMPANY
of Pennsylvania
MERTZTOWN, PENNSYLVANIA

New England Distributor
FRED A. HOUDLETTE & SON, INC.
40 Central Street
Boston, Mass.

STARKWEATHER & BROADHURST
INCORPORATED

Engineers and Contractors for
Water Works and Sewage Pumping Plants

79 MILK STREET, BOSTON HANcock 4530

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CAST IRON PIPE

The Central Foundry Company
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NEW YORK CITY

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BIRMINGHAM Comer Bldg.
DALLAS Praetorian Bldg.
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SMITH WATER VALVES
for Every Pressure.

SMITH Standard Gate Valves are available to handle every water pressure from 35 to 350 lbs. working pressure and even higher. These valves have been tested at pressures from 100 to 350 lbs. per sq. inch and higher.

SMITH
WATER WORKS SPECIALTIES & SUPPLIES
THE A.P.SMITH MFG.CO. *East Orange, N.J.*

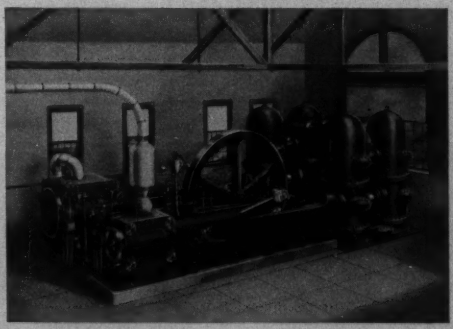
NOW! the
TYPE X
A Real Convenience
In Meter Box Covers
WITH the Type X Meter Box Cover, the lid is unlocked with the Ford Worm Lock which *lifts the lid and breaks the seal of ice or dirt.* Then the lid is slid forward to a stop and leaned back.
Hinge effect is obtained *without openings* in lid. *No mud, snow or leaves dragged into the box. Only one hand needed* in opening or closing meter box.
Write for Literature and Prices.
Notice neat appearance.
Simply slide lid forward and lean back.
The FORD METER BOX CO.
WABASH, INDIANA
WATER METER SETTING & TESTING EQUIPMENT

MURRAY IRON WORKS CO.

(INCORPORATED 1870)

BURLINGTON, IOWA, U. S. A.

Builders of High Duty Pumping Engines

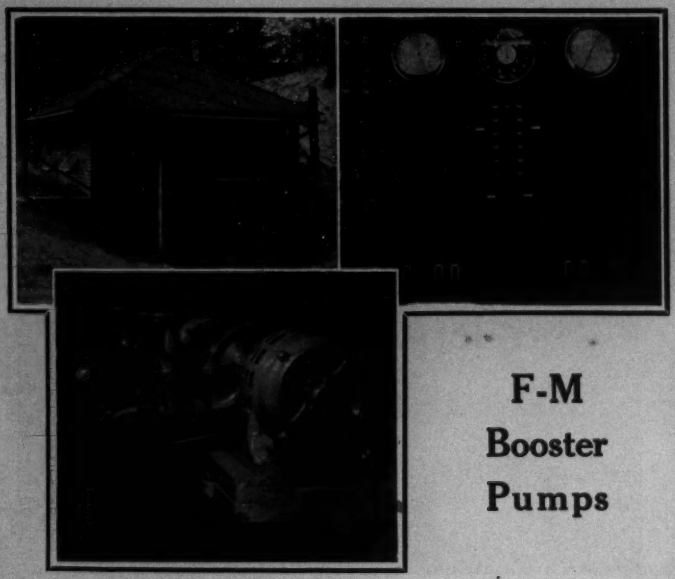


Murray High Duty Crank and Fly Wheel Pumping Engine, Opposed Type

STARKWEATHER & BROADHURST, INC.,
79 MILK STREET, BOSTON

will be glad to show you the superior design and excellent workmanship of the new 3 M. G. D. Murray Pump in the Arlington Pumping Station of the Metropolitan District Commission. Exceptional operating results are being obtained as shown by the official duty test which exceeded the guaranty by a substantial amount.

PLEASE SEND US YOUR SPECIFICATIONS AND CALLS FOR BIDS



F-M
Booster
Pumps

At SOUTH HADLEY, MASS.

Shown above are the exterior of the South Hadley Water Works Pumping Station, the two F-M Motor Driven Centrifugal Pumps installed in the station and the control equipment. The station is located at one extreme end of the town and takes water from a small reservoir under a positive head of approximately 12 or 15 feet and pumps it through the main section of the town to a standpipe at the other end. Both pumps and motors are of ball bearing design, which construction was selected because of the desirable feature of lubrication. The bearings require attention only once a year.

FAIRBANKS, MORSE & CO.

88 High Street, Boston

FAIRBANKS-MORSE

PUMPS · DIESEL ENGINES · MOTORS

DE LAVAL

Heavy Duty Waterworks Centrifugal Pumps

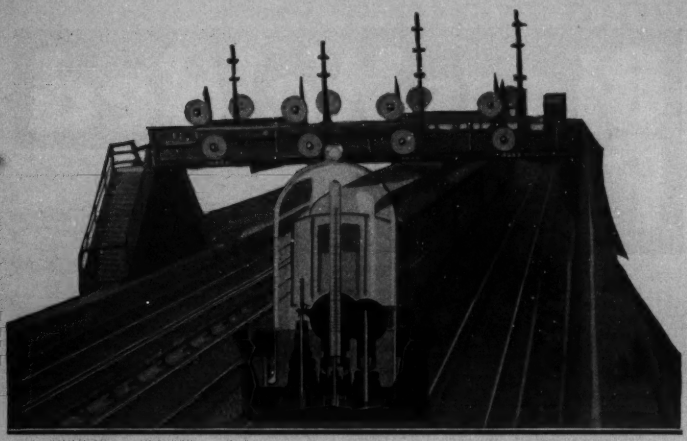
ONE OF TWO GASOLINE ENGINE DRIVEN PUMPS installed by us in the Water Works Pumping Station at Falmouth, Mass. The photograph shows the temporary location of one unit, on the shore of the lake, to protect the Town against possible water shortage while the permanent installation work was under construction.

De Laval Gasoline Engine Driven Centrifugals give absolute insurance against interruptions to water supply at low first cost, and are quickly and easily installed.

TURBINE EQUIPMENT COMPANY
OF NEW ENGLAND

80 Federal Street Phone LIBerty 5993 **Boston, Mass.**

SPECIALISTS IN AUTOMATIC PUMPING STATIONS



SAFETY LIES IN

CONTROLLED CHLORINATION

Too little chlorine today, too much tomorrow won't do.

Vacuum Control is positive control and W&T Vacuum Chlorinators are built to control chlorine accurately, dependably years from now—as they do the day they are installed.

The hydrostatic vacuum positively controls chlorine pressures. Mechanical check valves, diaphragms, springs and delicate control valves are all eliminated. Every vital part is in plain sight. Cleaning, adjusting and repair are a matter of minutes only.

Need you wonder that NO VACUUM CHLORINATOR HAS EVER WORN OUT.

Wallace & Tiernan Co., Inc., Newark, N. J. Branches in Principal Cities.

Ask for Technical Publication Number 38

A Product of

WALLACE & TIERNAN

The only safe water *is a sterilized water*

S A 27

Biggs Welded Pipe

BIGGSWELD
STRONGER THAN THE PLATE ITSELF

WATERWORKS engineers everywhere are placing more and more steel pipe in the ground year after year because of:

(1) Its dependability; (2) Its long life; (3) Its superior structural strength and ductility over other types; (4) Its low first cost; (5) The continuity of service and freedom from rupture which it assures.

Biggs Electrically Welded Steel Pipe has been accepted by the leading waterworks engineers. It has given years of continuous service in high pressure supply and distribution mains. A modern plant, a thorough knowledge of welding, accuracy, and close attention to detail, have made Biggs Pipe a recognized standard of comparison.

Biggs Pipe is furnished in 30″ diameter and larger sizes and in 36-foot lengths. It is preferred by contractors on account of the ease with which it is installed.

Complete specifications and data on request.

The Biggs Boiler Works Company,
Established 1887
Akron, Ohio

New York

Boston

Detroit

Cleveland

St. Louis

Kansas City

BIGGS Steel Pipe *Riveted and Welded*

The Biggs Boiler Works Co. AKRON, OHIO

PRECALKED JOINT PIPE

CAST IRON PIPE

Bell and Spigot—Sand Cast—Modern Weights

Sizes: 1¼ through 12 inches. Lengths to 16 feet

Boston stocks. Furnished with or without Precalked Joints

McWane Cast Iron Pipe Company

Eastern Office: 123 South Broad Street Philadelphia

Sales Representatives: FRED A. HOUDLETTE & SON 40 Central Street, Boston Eastern Mass., Me., N. H.

General Offices: BIRMINGHAM, ALA.
Foundries: BIRMINGHAM, ALA., PROVO, UTAH

Main's Hotcoating for the inside of standpipes and water tanks, will stop all pitting and corroding, and is guaranteed for seven years.

Also

Main's Coverall Salt Air Paint, for the outside of standpipes and water tanks, guaranteed for four years.

M. B. MAIN **Box 189, Somers Point, N. J.**

The "COREY" Hydrant

Why you should use GENUINE COREY HYDRANTS

Water to Nozzles quicker than other Hydrants.

Standpipe can be removed and replaced without shutting off water in main.

Ease of operation insured by knuckle joint principle.

Only 13 turns to completely open or completely close, but full flow with only 4 turns.

Nozzles screwed in — not leaded.

Can be lengthened without shutting off water.

Will not flood if broken.

Positive Drip — cannot freeze.

Standpipe can be revolved quarter turns — Nozzles always in right direction.

Write for copy of our new Catalog "G."

CHARLES L. BROWN,

New England Sales Manager, Lock Box 2, Northboro, Mass.

RENSSELAER VALVE COMPANY

TROY, N. Y.

New England Water Works Association

Specifications, Forms, and Meter Rate Sheets

Standard Specifications for Cast-iron Pipe and Special Castings,	per copy,	$0.25
Forms for Slow-sand Filtration Plants	per set,	0.30
Forms for Rapid-sand Filtration Plants	per set,	0.30
Meter Rate Sheets: Single sheet		0.05
100 sheets, in orange		2.50
100 sheets, in black		2.25

Water Works Contractors and Supply Houses!

Your card may be inserted as above at a rate of $12 per year.

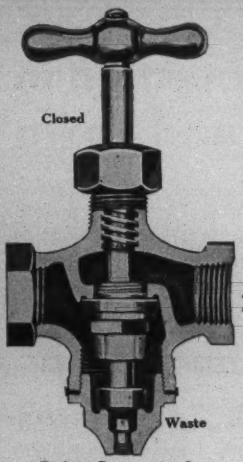
HIGHEST AWARD, GOLD MEDAL,
ST. LOUIS EXPOSITION, 1904

Over 100 Water Departments
use
LEAD-LINED IRON and TIN-LINED PIPES
for their service connections

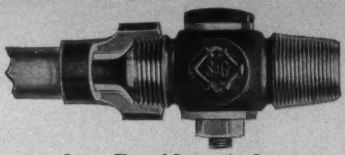
MANUFACTURED BY

Lead Lined Iron Pipe Company

Wakefield ═══ Mass.



Gorham Compression Stop and Waste Cock



Copper Flanged Corporation Stop

S. & G. Water Works Brass Goods

S & D Heavy Pattern Slip Type Service Boxes

Byers' Wrought Iron Pipe

Annaconda Brass Pipe and Copper Service Tubing

Service, Roadway and Valve Boxes

Cast Iron Pipe and Fittings

SUMNER & DUNBAR

12-18 Pittsburgh St., Boston, Mass.

Telephone, LIBerty 1350

PIERCE-PERRY CO.

SUCCESSORS TO

GEORGE E. GILCHRIST CO.

WHOLESALERS OF

Steel, Wrought Iron, Brass Pipe and Water Works Materials of all kinds including copper service pipe and fittings.

236 Congress St., Boston, Mass.

CEMENT LINED SERVICE PIPE

With Specially Adapted Lead-lined Fittings

Also Curb Cocks which eliminate Iron to Brass Corrosion both inside and out.

CEMENT LINED PIPE CO.

LYNN, MASS.

CLARK

METER BOXES

Cover and Lid Type

Perfect Lock
Wonder Lock
Worm Lock

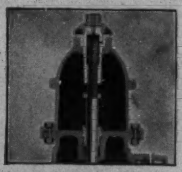
Permacrete
Gray Iron
Vitrified
Armco Iron

Investigate Permacrete Now

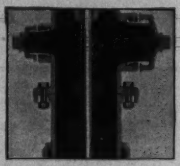
H. W. CLARK CO.

MATTOON, ILLINOIS

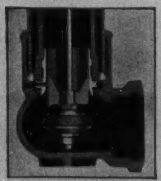
Better Fire Protection in City, Village and Town



Whether opened or closed, no moisture can seep down around operating nut or climb up through the stuffing box to freeze or cause rust in the revolving nut.



The swivel flange provides a completely revolving head, enabling nozzles to be faced in any direction without disturbing the barrel.



The non-revolving tapered main valve avoids water hammer and wear. Seating with the pressure, it prevents leakage or flooding if barrel is broken. It permits full capacity flow through hydrant when open.

Fire hydrants are the connecting link between the water in the mains and the fire fighting apparatus. A broken or crippled hydrant at the fire scene may mean untold loss—a black eye for the department.

MATHEWS
MODERNIZED HYDRANTS

are the leaders because, being easier to repair and replace, they are less likely to be out of service any length of time, and because they assure easy opening, and leak-proof closing. All working parts are rust-proof and frost-proof. A broken Mathews cannot leak to cause damage by flooding, and the broken barrel is easily replaced without digging or breaking the pavement.

The Mathews has been the leader for more than three score years. Over 350,000 are in use throughout the world, *giving better fire protection in city, village and town.*

Write for the new MATHEWS MODERNIZED HYDRANT BOOKLET which shows clearly the replacement-without-digging and other advantages which have created the preference for Mathews.

R. D. WOOD & CO.

In business continuously since 1803

400 Chestnut Street :-: Philadelphia

CAST IRON PIPE AND FITTINGS

SAND SPUN (centrifugally cast) and PIT CAST (Reg. U. S. Pat. Off.)

GATE VALVES

6-inch or 60-inch

—each Kennedy Valve size and type is efficient, dependable, long-lived

THE large Kennedy Valve line includes practically every standard type and size for water works, sewage pumping and fire protection service — all with one outstanding characteristic. This prime characteristic of every Kennedy Valve is its thorough suitability for the service on which it is to be used. When you buy a valve recommended by our long-experienced engineering department, you can be sure that it is designed with an ample margin of strength for pressure and service strains, that it is carefully and accurately built for easy and dependable operation, and that it is made of high grade materials which will stand up for many a year.

Water works superintendents and fire chiefs who have seen Kennedy Valves in action, testify to their thoroughgoing merit. You are safe when you standardize on Kennedy for valves and fire hydrants.

THE KENNEDY VALVE MFG. CO.
Elmira, N. Y.

Branches in principal cities

KENNEDY

VALVES~PIPE FITTINGS~FIRE HYDRANTS

THE STANDARD FOR 50 YEARS

Automatic Pressure Control Valves
Feed Water Filters
Portable Fire Hydrants
Hydraulic Engines
Hydraulic Engines—Booster Pumps

ROSS VALVE MFG. CO., INC. TROY, N. Y.

Health and Protection First

Water delivered through dirty pipes may be a MENACE.

Incrusted water pipes mean inefficiency and loss of Fire Protection.

We Guarantee the Results of Our Method of Cleaning.

WRITE US.

National Water Main Cleaning Co.

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HAYES PUMP AND MACHINERY CO.

94 PEARL ST., BOSTON, MASS.

Pumping Plant Contractors

CENTRIFUGAL, POWER, STEAM PUMPS

STEAM TURBINES
WATER WHEELS

ELECTRIC MOTORS
OIL ENGINES

GOLDEN-ANDERSON

Patent Automatic Cushioned Controlling Altitude Valves

We have enlightened many a water user in municipalities, in industrial plants and on railroads, as to the adaptability of these Golden-Anderson Valves, and as to their function of SAVING, and of eliminating troubles.

For automatically maintaining Uniform Stage of Water in Tank, Reservoir or Standpipes. Doing away with the annoyance of Freezing and Float Fixtures inside or outside of Tanks.

"Three Ways of Closing These Valves":
1st —Automatically, by water.
2nd—By Electricity, if desired.
3rd—By Hand

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe. No valves or fixtures inside or outside.

Sizes to 24 in.

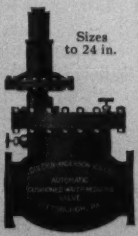
Remember!

"HOSTS OF REFERENCES"
Valves cushioned at all times by air and water
No water hammer or bursting mains

"Made with stop starter attachment for centrifugal pumps"

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required — No attention necessary.
5. Positively no hammering or sticking.



Sizes to 24 in.

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

They carry a constant water level in feed water heaters by perfectly controlling the flow of makeup water.

Operated by protected enclosed copper float.

Cushioned by both air and water.

Operate without hammering, sticking or chattering. No metal-to-metal seats. Made angle or straightway.

Sizes 1 in. to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle — Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air.

Angle or Globe

Sizes to 24 in.

GOLDEN-ANDERSON
Patent Automatic Double Cushioned Check Valve

Sizes to 24 in. Angle or Globe

Automatically prevents reverse flow of pressure. Perfectly cushioned to prevent shock or hammer. Especially adapted for water works to prevent disastrous reverse flow of pressure due to pumps stopping. Arranged so that quick or slow operating may be obtained.

Golden-Anderson Valve Specialty Co., 1325 Fulton Bldg., Pittsburgh, Pa.

LOUISVILLE NOW USES THE CHLORO AMMONIA TREATMENT

LOUISVILLE, Kentucky, recently installed two new type PARADON Solution Feed Chlorinators and a PARADON Ammoniator.

The Chloro Ammonia treatment provides very efficient sterilization. Its use is especially advantageous on waters subject to high organic or bacterial content. With such waters it prevents tastes, odors and aftergrowths. It permits a much wider latitude on such types of water than is possible with chlorination alone.

It is particularly fitting that Louisville should choose a PARADON—the pioneer ammoniator in the United States was installed a little more than two years ago by PARADON at Lancaster, Pennsylvania.

Send for Bulletin N–24 describing the PARADON Ammoniator. Bulletin N–28 describes the PARADON Solution Feed Chlorinator.

THE PARADON COMPANY
Arlington, New Jersey.

Paradon
CHLORINATORS
for
City and Private Water and Sewage Systems, Industrial Plants and Swimming Pools.

W 24 sm

Type of Eddy Hydrant Popularly Used

More Than Sixty Years of Experience Goes Into All

EDDY

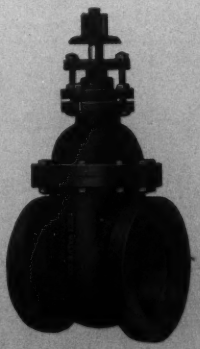
Hydrants and Valves

BUILT TO MEET EVERY EXACTING REQUIREMENT OF WATER-WORKS SERVICE

Practical water-works men instantly recognize the superior features of Eddy products. For instance, with the hydrant.

A damaged valve can be replaced in a few minutes — Water hammer is avoided by the valve closing against the pressure and the use of the cut-off under the valve, which gradually closes it —
Stems cannot be bent in closing the hydrant.
Nothing can lodge on the valve seat to prevent closing of the valve —
The Drip Rod can be removed without interfering with the hydrant in any manner —
The position of the stem of the hydrant indicates accurately the position of the valve —
Whatever can pass the valve opening will pass the standpipe —
No frost case necessary —
All of these points are explained thoroughly in our catalogue, which will pay you to study.

The Eddy Valve, Too



Has its distinctive and individual features. The double disk gates are free to adjust themselves in different positions every time the valve is closed, thereby keeping smooth and tight faces. And two bronze hooks on the ball loosely engage with the gates to prevent them from spreading at the top. The center bearing gates are forced to their seats with equal pressure at all points. There is a good deal more worth knowing about Eddy Valves. Further details will be sent for the asking.

Other Eddy Products

The Eddy line of water-works products also includes horizontal and vertical check valves, foot valves, hydraulically operated valves, indicator posts, etc.
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WRITE FOR CATALOGUE

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WATERFORD, N. Y., U. S. A.

DONALDSON IRON CO.

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...OF...

CAST IRON PIPE

...AND...

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Also Flange Pipe and Fittings.

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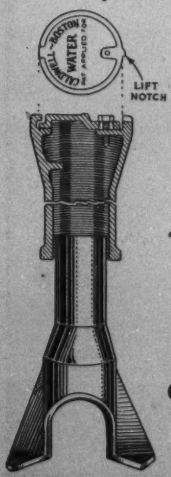
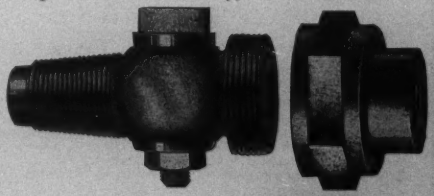
LEHIGH COUNTY, PA.

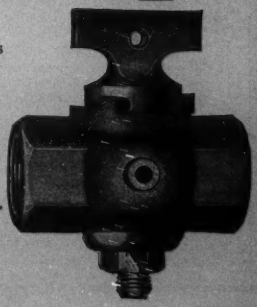
The "BEST" Cast Iron Curb Box

Top section is interchangeable with the "Slide Type" Buffalo Box



No change necessary in wrench or shut off keys





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Brass Goods, Curb and
Valve Boxes

None better and few as good

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(Every Atom Pure Lead)

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For overhead joints, or in wet places where the use of molten lead is not only impracticable but dangerous — **LEAD WOOL** may be used to advantage.

It makes an absolutely tight joint which will withstand the highest pressure, yet be sufficiently elastic to allow considerable sagging or settling of the pipe without danger of a leak.

As compared with the poured joint, in this respect, the superiority of **LEAD WOOL** is apparent.

Manufacturers of

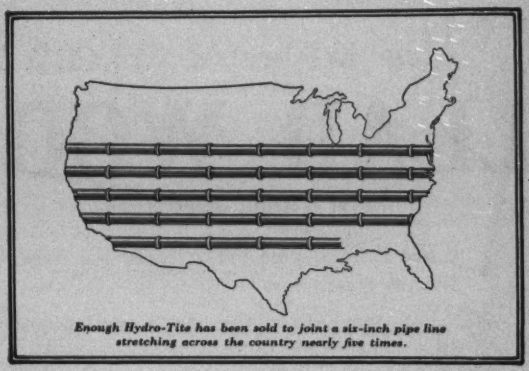
Lead Pipe, Tin Lined Lead Pipe, Pure Block-Tin Pipe, Solder, White Lead and Red Lead.

HIGHEST QUALITY SOFT BRANDS

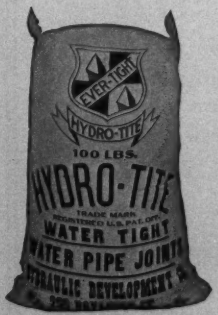
PIG LEAD

HYDRO-TITE

— *its record . . .*



Enough Hydro-Tite has been sold to joint a six-inch pipe line stretching across the country nearly five times.



HYDRO-TITE is always the same, comes in moisture proof, non-dusting bags, is shipped the day order is received. Every bag is subject to a guarantee which makes it impossible for you to lose by trying this modern pipe jointing material.

. . . over 21 years without a failure

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HYDRO-TITE

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B297

There can be no ECONOMY where there is no efficiency . . . .

Beaconsfield

MAKE A CHECK UP OF THE hours, possibly days, which you've lost due to faulty valves that require constant repair or replacement. Figure out how much you are losing by using a valve of uncertain value, that you purchased on a "low price" basis.

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that keeps pace with progress

"The finest contribution in twenty years"

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Win the respect of the coming generation. Standardize on Ludlow — the only fully modern hydrant. A cost of less than 2¢ per unit per year for repair parts, is the record established during half a century by 8,000,000 Ludlow Valves and Hydrants in over 3,000 cities and towns. Ludlow quality insures *lasting* economy.

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TROY · NEW YORK

MAKERS OF DEPENDABLE VALVES AND HYDRANTS SINCE 1866

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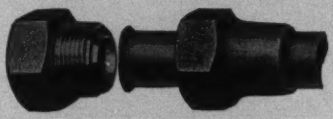
Regular Corporation Stop

Adapter

In making an installation with Hays Copper Service Fittings the regular Corporation Stops can be used in conjunction with the adapter. It is not necessary to procure new mandrels, as the Corporation Stops are inserted with the regular mandrels, in the usual manner, after which the adapter is attached.



Open View of Adapter

These adapters are made with Female Thread for Increased I. P., Water Works Standard or Lead Flange.

To use standard Corporation Stops with Increased I. P. or Water Works Standard Thread, and where a direct connection of the Corporation Stop and Copper Pipe is desired, the above stop has been designed. (See cut above for sectional view of joint.) These stops permit a Hays 90° seal with the use of regular male mandrels.

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The Hays Copper Plumbing Method for Water Works and House Plumbing

Hays Manufacturing Co. Erie, Pa.

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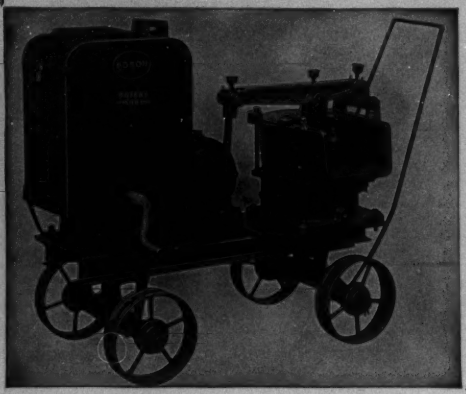
Hand Pumps. Heavy Duty and
Light Portable Power Pump Outfits



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Special Castings *Short Body B. & S. Specials*

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WORKS: PHILLIPSBURG, N. J. and EVERETT, MASS.

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WROUGHT IRON PIPE. (See Pipe, Wrought Iron and Steel.)

Watermains Equations:

Strength + Flexibility = Safety

Steel + Coating = Durability

Hot Dipped Steel Pipe=Dependability

The STEEL WATERMAINS ASSOCIATION, INC. is a trade association of steel pipe manufacturers, who have for many years supplied municipalities with their requirements in large diameter steel pipe. Their products have in the past successfully met the most rigid specifications, and have given satisfactory service.

The object of our association is primarily to develop general publicity, to establish closer and more rational relations between buyers and fabricators, to assist customers in the preparation and development of their projects by supplying them with reliable data.

We solicit correspondence from any one interested, be he taxpayer, engineer in charge, commissioner or contractor.

Steel Watermains Association, Inc.

Huff Building

Greensburg, Pa.

CHARLES V. WITT, Chief Engineer and General Manager.

Artist's conception of Barbara Frietchie's Home in Frederick, Maryland

DeLavaud Pipe . . .
supplies and protects the historic town of Frederick, Maryland

FREDERICK, MARYLAND is associated in the minds of most Americans with the story of dauntless Barbara Frietchie—she who defied the invading troops to destroy her country's flag. Just how much the present-day town of Frederick cherishes the memory of its heroic daughter is shown by the beautiful Barbara Frietchie monument and the charming replica of her little home (shown above).

To serve and to protect the town of Frederick, Whitman, Requardt & Smith, Consulting Engineers, specified 18,000 ft. of deLavaud pipe for underground water mains. For deLavaud pipe is the strongest pipe ever cast. It is produced by pouring molten iron into a rapidly revolving cylindrical mold. The metal of the pipe thus formed is dense, fine-grained and remarkably free from impurities.

"We have found deLavaud pipe to be satisfactory in every respect," writes E. St. C. Maxwell, City Engineer of Frederick. "We find it to be a stronger pipe than sand cast and at the same time to cut and tap with ease. The absence of the bead facilitates assembly and produces a joint with greater flexibility."

DeLavaud Pipe is made in accordance with U. S. Government specifications. We are also furnishing this product in the various thicknesses and weights shown in the specifications of the American Water Works Association and the American Gas Association. The deLavaud Handbook gives complete information. Write for free copy today.

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Our pipe bears the "U-Check" trademarking of The Cast Iron Pipe Research Association

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with reports of the discussions. Many of the contributions are from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between the members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness. ALL MEMBERS OF THE ASSOCIATION RECEIVE THE JOURNAL IN PART RETURN FOR THEIR ANNUAL DUES; to all others the subscription is four dollars per annum.

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The Fort Hill Press
SAMUEL USHER
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